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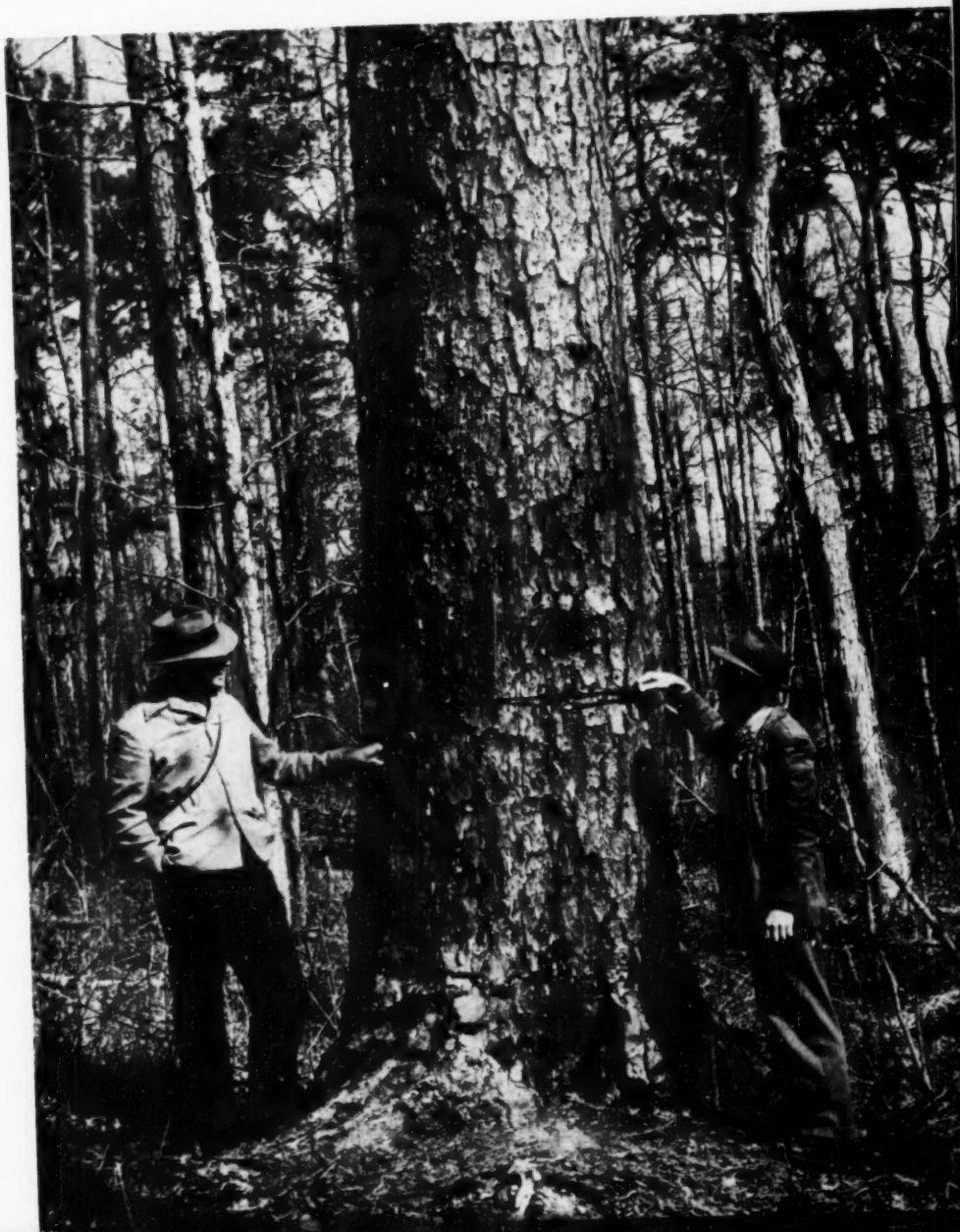

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Photo by Tennessee Coal, Iron & R.R. Co. shows W. A. Belcher, president, W. A. Belcher Co. and David Hampe, chief forester for TCI measuring the tree's 10-foot, 9.5-inch circumference. The tree was recently felled.

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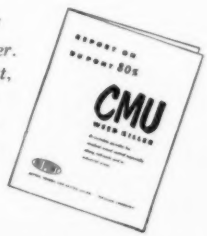

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Journal of Forestry

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A Classification of the Climax Forests of Southeastern Alaska

R. M. Godman
Forester, Alaska Forest Research Center, Juneau.

THE TONGASS NATIONAL FOREST, comprising nearly all of southeastern Alaska, has approximately 3 to 4 million acres of commercial timber (*1*). Three condition classes have usually been recognized: saw-timber, climax or pulp timber, and even-aged second growth. The saw-timber stands generally occur in scattered pockets and are predominantly a spruce type. They usually average over 35 inches in diameter and have volumes of 40,000 board feet or more per acre. Such saw-timber stands are actually mature areas of even-aged second growth. Left uncut they gradually break down to form the uneven-aged climax. Second-growth stands seldom exceeding 100 acres in area consist of spruce and hemlock mixtures occurring where saw-timber was cut, on windthrown areas, slides, or abandoned Indian villages. The remainder of the commercial timberland, estimated to be about 75 percent of the total area, carries the climax type on which pulp cutting will soon start.

No commercial cutting has ever been done in this climax. Extensive rough surveys have been made to determine approximate pulp-timber volumes but beyond that the type has remained an unknown quanity. Yield tables for the even-aged second growth were constructed 20 years ago (*10*). These were recently checked to compare 20 years of actual growth with that predicted, and the tables proved fairly accurate. After the climax is cut for pulp, new young even-aged stands will regenerate naturally on the cut-over land, but what their quality or site index will be cannot be predicted from the present climax. The use of total tree height of the dominant stand at a given age (site index) as discussed by Roth (*6*) and clarified by Watson (*11*) does not apply here. The method for uneven-aged stands developed by Duerr and Gevorkiantz (*3*) cannot be used either as there are few climax stands having remnants of the original even-aged pre-climax. Furthermore our interest in assigning a site number or any designation to these decrepit climax stands is for the purpose of indicating, if possible, what the land is capable of producing in even-aged second growth. The climax is making almost no growth. Increment is largely offset by mortality. The trees vary in age from a few years to a thousand years, often on a tenth acre, so average age is meaningless. Height growth is being made only by a few struggling young trees trying to make their way into the crown canopy from small openings created by falling veterans, and may be considered static for the stand.

It might be contended that because the stand has finished productive growing and is now maintaining itself as a stable climax, the quality of the site is expressed in the final gross volume maintained. However the classification presented is not called a site classification, as there are too many unknown factors involved. The present need is for some scheme of classification which will give a fairly complete picture of stand characteristics of the climax. If site cannot be accurately determined by means of vegetation, soil, or other factors (which are still being tested), before cutting, then possibly, after new young stands form on the same area, a comparison of these class characteristics with the site index of the new stands will throw light on the subject. Such a classification will also aid in planning cutting and logging procedures and stand improvement measures necessary for securing adequate natural regeneration. With these needs in mind the classification scheme presented in this paper was devised.

Method

Preliminary analysis of 250 plots measured on all slopes, aspects, and elevations, sampling all gradations of habitat and types, emphasized that climax stands are highly variable in character. Within gross cubic volume classes, with spreads of only 200 cubic feet, representing the summation of growth in climax stands, the range in average diameter was very wide. The same was true of average number of trees, average number of logs per acre, age, and other factors when substituted for diameter.

Preliminary plot analysis showed that the average number of logs per tree in the dominant class is the most practical single indicator of what the area has been able to produce. For this purpose, the number of 16-foot logs, taken to a 6-inch top d.i.b., compares favorably with total tree height (*1*) and is easier to ascertain. The degree of stocking does not appear to influence the individual tree height in the relatively open climax stand. Stand changes over several decades alter the height of the dominant class very little in a climax forest. Merchantable height in number of

logs is almost always estimated when cruising, so the information is usually available without extra effort.

For the purpose of this classification, number of 16-foot logs should be computed or estimated from the trees in and above the average diameter class for that part of the stand 8 inches d.b.h. and larger. This procedure eliminates understory trees, restricting it largely to the dominant trees. In climax stands, trees in and above the average stand-diameter class usually represent about one-third of the stems and at least two-thirds of the volume. They are restricted to the major species. Live cull trees need not be excluded, as they are normally as tall as merchantable trees and have similar variations in log-height.

Volume and number of trees per acre are only indirectly correlated with average log-height of the dominants but normally there is only a narrow spread around the average stand diameter within a given log-height class. Thus a specific class based on log-height is fairly well limited in the characteristics of its components.

TABLE 1.—AVERAGE STAND CHARACTERISTICS FOR DIFFERENT LOG-HEIGHT CLASSES (ACRE BASIS)

	Class				
	5	4	3	2	1
	2 logs	3 logs	4 logs	5 logs	6 logs
Cu. Vol. 12 in. d.b.h. and larger—Gross	1,609	3,534	6,257	9,532	14,305
Cu. Vol. 12 in. d.b.h. and larger—Cull	724	1,308	2,127	3,146	4,291
Cu. Vol. 12 in. d.b.h. and larger—Net	885	2,226	4,130	6,386	10,014
Cu. Vol. 8 in. d.b.h. and larger—Gross	2,037	3,971	6,586	9,727	14,449
Cu. Vol. 8 in. d.b.h. and larger—Cull	915	1,460	2,243	3,256	4,392
Cu. Vol. 8 in. d.b.h. and larger—Net	1,122	2,511	4,343	6,471	10,057
Cu. Vol. 8 in. d.b.h. and larger—Percent Cull	45	37	34	33	30
Average d.b.h. 8 in. and larger	14.9	17.0	20.5	24.2	26.5
Basal area, square feet	130	170	233	294	389
No. trees 1 in. to 7 in. inclusive	71	67	55	32	21
No. trees 8 in. to 11 in. inclusive	44	37	26	18	14
No. trees 12 in. and larger	54	68	76	74	87
Total No. trees 8 in. and larger	98	105	102	92	101
No. live culls 8 in. and larger	18	12	10	10	9
Percent culls 8 in. and larger	18	11	10	11	9
Cubic foot growth per year	9	23	48	67	73
Cubic foot mortality per year	6	9	13	13	20
Spacing, trees 8 in. d.b.h. and larger in feet	21	20	21	22	21
Spacing, live culls in feet	49	60	66	66	70
No. 16-foot logs, Merchantable	122	213	259	277	379
No. 16-foot logs, Cull	28	49	31	32	33
No. 16-foot logs, Total	150	262	290	309	412
Average log height trees 8 in. d.b.h. +	1.6	2.6	2.9	3.5	4.3
Percent volume by species—Spruce	4	8	9	16	41
Percent volume by species—Hemlock	25	57	71	74	49
Percent volume by species—Cedar	56	30	20	10	10
Percent volume by species—Other	15	5	0	0	0
Average Girard Form Class (16-foot)	78	82	84	85	87
Basis, No. plots	12	21	68	64	16

Characteristics of the Classes

Table 1 summarizes the characteristics of stands of different log-height classes. Two logs represent Class 5, or Scrub. Any stand having an average of less than 1½ logs would almost certainly occur on a muskeg, and have a very small volume. Six logs represents the class of highest volume for climax stands. Although greater volumes can be found, they will most likely be in saw-timber stands of spruce, relatively even-aged and limited in area.

Regardless of the class, the average number of trees 8 inches and larger remains nearly constant. The change in log-height class is reflected in an increase in average diameter and number of logs. In the 2- and 3-log classes 42 percent of the trees are less than 8 inches in d.b.h., but in the 6-log classes only 20 percent are less than 8 inches in diameter. With a fairly constant number of trees 8 inches and larger per acre in each class, a certain amount of overlap in diameters and resulting volumes is not unusual. However the average volume for each class is significantly different from that of the next class.

Cull volume is based on visible cull plus an additional 15 percent for unseen defect and breakage in the remaining net volume. The 15 percent allowance appears reasonable because fungus diseases are widespread in climax stands and are often difficult to detect (5). Visible defect was recorded as a percentage of the tree up to 50 percent for hemlock and cedar, and 33⅓ percent for spruce. Larger amounts of defect made the tree a total cull. Of the visible defect, rot and excessive limbiness in the top log caused 97 percent of the total defect. The amount of cull, as a percentage of the number of trees or of gross volume, decreases as the stand quality improves, the poorer stands being about half cull and the better stands about one-third cull.

Growth and ages were determined from increment borings taken on the plots, sampling all diameter classes. There was no correlation of radial growth rates with diameter or age. Excluding Class 5, the diameter growth rate averaged .08 inches per year over the past 40 years. Crown class, log-height class, or species had little if any influence on radial growth. Differences of 200 years in age of trees of the same diameter, or of 500 years within a tenth-acre plot were common. In general ,the best volume growth per acre in climax stands is not quite as good as that of the poorest second-growth stands.

Hemlock is the predominating species in the climax except in the poorest classes. In the southern part of southeastern Alaska, where most of the basic data were collected, the cedars constituted the bulk of the volume in Class 5. Classes 3 and 4 may be either a hemlock or cedar type, although hemlock tends to predominate over a large area. In Classes 1 and 2 the stands are primarily hemlock and spruce, with spruce forming as much as 41 percent by volume in Class 1. Stands with over 50 percent of the volume in spruce are

normally the even-aged preclimax saw-timber type having denser stocking and taller trees than in typical climax stands.

Form class (Girard) increases with stand volume and generally is reflected by the species composition. Cedar, which occurs on poor sites, has an average form class of 78, whereas the hemlock on better areas averages about 86. Bark thickness and taper are greater in the lower classes. The form class of each species is generally higher in the better stands although there is considerable variation.

Table 2 shows where the various classes are most likely to occur. In general, the best stands occur at the lower elevations on moderate slopes with a southern exposure. Poor stands are common on northern exposures and on the gentle to flat slopes which are often semi-muskegs, at various elevations. The maximum elevation of the plots was 1,200 feet, although commercial stands may occur above this elevation in the southern part of southeastern Alaska.

No correlation was found between the classes and the lesser vegetation. The dominant cover in all classes was *Vaccinium* (*V. ovalifolium, V. parvifolium V. membranaceum*). The vegetation was denser and thriftier in the poorer stands than in the good stands, probably because of the influence of the tree cover and degree of shading rather than a site effect (*2*). The species most abundant in association with *Vaccinium* included salal (*Gaultheria Shallon*) and fool's huckleberry (*Menziesia ferruginea*) in the poorer stands, with bunchberry (*Cornus canadensis*) and ferns in the better stands. In all the undisturbed stands mosses and lichens form a solid mat. The lesser vegetation indicates mediacid soil conditions, or a pH between 4.0-5.0 (*7*).

Application of the Classification

Forest Service mapping standards for unmerchantable timber types are descriptive of site. Subalpine and scrub are choice examples. These 2- to 3-log-height classes will often have inoperable volumes, although they may be intermingled with the better stands. Tentative standards require that there must be 2,400 *net* cubic feet or more per acre for the stand to be considered merchantable.

Whether Class 4 (3 logs) will have merchantable volume per acre when the average cull factor is applied will depend on the diameter limit used. If the minimum diameter is set at 8 inches, the class will barely reach the minimum net volume, but if 12 inches is used then the average Class 4 is unmerchantable, as shown in Table 3.

For extensive reconnaissance of pulp timber areas in southeastern Alaska, the use of Table 3 could be expected to give close volume esti-

TABLE 2.—DISTRIBUTION OF LOG-HEIGHT CLASSES BY SLOPE, ASPECT, AND ELEVATION

		Log Height Class				
		2 logs	3 logs	4 logs	5 logs	6 logs
		Percent				
Aspect	North	75	44	23	21	7
	East	17	11	31	15	36
	South	8	17	20	33	43
	West		28	26	31	16
Slope	0-20	59	28	23	22	12
	21-40	8	28	18	26	44
	41-60	33	28	29	31	25
	61 +		16	30	21	19
Elevation	0-400	33	33	36	27	50
	401-800	25	23	21	47	31
	801-1,200	42	44	43	26	19

TABLE 3.—GROSS CUBIC VOLUME BY NUMBER OF TREES, AVERAGE D.B.H. AND LOG HEIGHT[1]

D.b.h.	Number of trees 8 inch d.b.h. and larger per acre								
	140	130	120	110	100	90	80	70	60
	Gross cubic volume per acre to 6 inch top								
	2 Logs—Class 5								
10	1,525	1,416	1,307	1,198	1,089	980	871	762	653
12	1,984	1,842	1,700	1,559	1,417	1,275	1,134	992	850
14	2,579	2,395	2,210	2,026	1,842	1,658	1,474	1,289	1,105
16	3,307	3,071	2,834	2,598	2,362	2,126	1,890	1,653	1,417
18	3,984	3,700	3,415	3,131	2,846	2,561	2,277	1,992	1,708
20	47,60	4,420	4,080	3,740	3,400	3,060	2,720	2,380	2,040
	3 Logs—Class 4								
12	3,080	2,860	2,640	2,420	2,200	1,980	1,760	1,540	1,320
14	3,900	3,622	3,343	3,065	2,786	2,507	2,229	1,950	1,672
16	4,806	4,463	4,120	3,776	3,433	3,090	2,746	2,403	2,060
18	5,921	5,498	5,075	4,652	4,229	3,806	3,383	2,960	2,537
20	7,314	6,791	6,269	5,746	5,224	4,702	4,179	3,657	3,134
22	9,100	8,450	7,800	7,150	6,500	5,850	5,200	4,550	3,900
	4 Logs—Class 3								
16	5,936	5,512	5,088	4,664	4,240	3,816	3,392	2,968	2,544
18	7,420	6,890	6,360	5,830	5,300	4,770	4,240	3,710	3,180
20	9,040	8,394	7,748	7,103	6,457	5,811	5,166	4,520	3,874
22	10,794	10,023	9,252	8,481	7,710	6,939	6,168	5,397	4,626
24	12,817	11,901	10,986	10,070	9,155	8,239	7,324	6,408	5,493
	5 Logs—Class 2								
20	10,286	9,551	8,816	8,082	7,347	6,612	5,878	5,143	4,408
22	12,418	11,531	10,644	9,757	8,870	7,983	7,096	6,209	5,322
24	14,802	13,745	12,688	11,630	10,573	9,516	8,458	7,401	6,344
26	17,436	16,190	14,945	13,699	12,454	11,209	9,963	8,718	7,472
28	19,944	18,520	17,095	15,671	14,246	12,821	11,397	9,972	8,548
	6 Logs—Class 1								
22	14,658	13,611	12,564	11,517	10,470	9,423	8,376	7,329	6,282
24	17,402	16,159	14,916	13,673	12,430	11,187	9,944	8,701	7,458
26	20,034	18,603	17,172	15,741	14,310	12,879	11,448	10,017	8,586
28	22,652	21,034	19,416	17,798	16,180	14,562	12,944	11,326	9,708
30	25,396	23,582	21,768	19,954	18,140	16,326	14,512	12,698	10,884

Av. form class by log-height class: 2-78; 3-82; 4-84; 5-85; 6-87
Av. cull factor by log-height class: 2-45; 3-37; 4-34; 5-33; 6-30

[1]Area above block lines will have less than 2,400 cubic feet per acre *net* volume when average cull factor for class is applied. Volumes less than this are considered unmerchantable for pulptimber.

Cubic volumes from (*8*). Average Girard form class for each log height class used.
Aggregate difference from basic data = —1.4 percent.
Standard error of estimate = 11 percent.

mates, and the class would indicate present characteristics of the stand.

Summary

1.—A classification scheme for the climax forests of southeastern Alaska was needed to show the characteristics of the present stands and to aid in determining methods of estimating future yields of the second growth that will follow cutting the climax stand.

2.—The average number of 16-foot logs to a 6-inch top d.i.b. of trees in and above the average stand diameter was found to be the most practical single indicator of stand characteristics in the climax forests. The stand above the average diameter represents at least two-thirds of the gross volume that occurs in about one-third of the trees. Log-height is roughly indicative of species composition, gross volume, and average diameter. In the field it is easily recognized and measured.

3.—Five log-height classes represent the range of sites in timbered areas of the climax forest. Average per-acre volumes differ significantly between classes, the larger volumes occurring in the higher classes.

4.—Climax forests are defective; about one-half the gross volume is cull in the poorest stands and approximately one-third is cull in the better stands. The largest trees are most defective.

5.—Diameter growth averages .08 inch per year, with essentially no difference in this rate between species, crown classes, log-height, or age groups. Mortality is erratic. The best net volume growth in climax stands (averaging slightly over 50 cubic feet per acre per year) is less than that on the poorest second-growth site.

6.—Hemlock is the predominant species except in the poorer classes, where cedar often leads. Spruce does not occur as a pure type in the climax forest, but does form a high proportion of the volume in Classes 1 and 2. Species composition is reflected in the log-height classes to a large extent.

7.—The Girard form class increases for each species as the stand volume increases. On the poorest areas, where cedar is prevalent, the average form class is 78; on the better areas, where hemlock and spruce predominate, it is 87.

8.—The best stands occur at the lower elevations on moderate slopes with a southern exposure. Poor stands are common on northern exposures and on poorly drained slopes and flats at various elevations.

9.—The dominant ground cover vegetation in all classes is *Vaccinium*. The lesser vegetation indicates a mediacid soil condition.

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Decay Resistance of Second-Growth Douglas-Fir

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A NUMBER OF STUDIES were initiated in late 1946 at the Forest Products Laboratory with the purpose of characterizing more completely the wood of coast-type, second-growth Douglas-fir. Some of the observations and related information have already been published (*3, 5, 6, 7, 8, 9, 10*). Each of the several studies is based to a large extent on samples from the same trees; this gives a degree of coherence among the respective findings that may prove useful in certain connections. Also, in order to consider the effect of growing conditions on the character of the wood, the trees furnishing the samples were selected on areas of different site quality for Douglas-fir.

This paper describes the testing procedures and results relating to the decay resistance of the second-growth wood. The information is based on so-called accelerated tests, which in this case, were made in two ways: in the laboratory—with pure cultures of decay fungi, and in the field—with small stakes set in the ground.

Procedures

Selection and Preparation of Test Material

The wood was taken from 34 trees in two fully stocked stands at elevations between about 2,500 and 3,000 feet on the Willamette National Forest, Oregon. One of the stands, furnishing half the trees, was on an area of Site Quality II for Douglas-fir and the other was on an area of Site Quality IV. The trees on Site II had an average age of about 100 years and a d.b.h. of 15 to 36 inches; those on Site IV had an average age of about 150 years and a d.b.h. of 10 to 27 inches. The significance of the site ratings and further information about the stands are given in earlier reports (*5, 7*).

From all the trees, 18-inch trunk sections located approximately 6 to 8 feet above the ground were used. In addition, like sections from higher elevations in three of the trees on each site were used to ascertain such differences in decay resistance as there might be vertically in the trunks. Except for supplementary observations, the tests were made on heartwood exclusively. Where there was any question about the location of the heartwood boundary a colormetric check was made (*1*).

The heartwood of each trunk section was sampled in three different radial zones: the outer heartwood, the middle heartwood, and the inner heartwood, as delimited, respectively, by the outer, middle, and inner thirds of the heartwood radius. Opposite sides of each section were sampled in this way so that each of the three zones was represented twice in each section.

Specimens for the decay tests were sawed from the respective zones. Those for testing in the laboratory were 1 by 1 by $\frac{3}{8}$-inch blocks, with the short dimension in the direction of the grain; those for testing in the field were 1 by 1 by $7\frac{1}{2}$-inch stakes with the long dimension in the direction of the grain.

Decay Tests

The laboratory tests were made in 6-ounce, screw-topped bottles of the French square type, with malt agar as the nutrient substrate for growing the test fungi. A single block and species of fungus were placed in each bottle. Except for a difference in size of test block and in the selection of test fungi, the procedure was the same as that earlier described for tests made on small blocks of oak wood (*12*). The duration of the tests was 4 months. The amount of decay occurring in the blocks was measured by the percentage loss in dry weight.

Six decay fungi were used: two strains of *Poria monticola* (Madison 698 and Madison 575), *Poria xantha* (Wash. 94155), *Poria incrassata* (Madison 563), *Fomes pinicola* (Wash. 15348-S), and *Fomes roseus* (Madison 701). These were selected from a group of 15 prominent wood rotters on the basis of preliminary tests in which they appeared to be most able to cause decay in Douglas-fir heartwood. With the possible exception of *F. pinicola*, all are known to attack Douglas-fir in service although their relative importance in this respect has not been established. *F. pinicola* is known to attack Douglas-fir slash and down timber.

The field tests were made on three different plots, near Madison, Wis.: a white pine woods, a nearby oak woods, and a prairie site which was about 30 miles distant from the wooded plots. The diversification of testing site was included because the results might be influenced by the type of vegetative cover as it determines the species of decay fungi present in the soil and surface litter. Moreover, it was felt that information on this point was needed for improving general test methodology as well as for its bearing on the immediate problem.

The test stakes were set in the ground to a depth of $6\frac{1}{2}$ inches; one inch of wood thus remained above ground to mark the location. They were labeled with both indelible pencil and India ink, and their positions relative to one another were mapped. The latter precaution proved helpful in identifying many of them at the end of testing. The test plot on the prairie site is shown in Figure 1.

All 34 trees and sample parts of the trees were represented on each plot. The position of the respective stakes on a plot was determined by random selection. In addition to the stakes of second-growth Douglas-fir, a few from the outer heartwood of five virgin-growth trees were included for comparison.

The stake tests were started in September 1947 and terminated 26 months later. As with the laboratory tests, decay was measured by the loss in dry weight of wood. For this purpose, before and after test-

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FIG. 1.—Test plot No. 3, on a prairie site near Madison. When completely set, the stakes projected only 1 inch above ground.

ing the stakes were conditioned to equilibrium weight in a room with maintained relative humidity and temperature. The weight-loss method of appraisal is believed to have advantages in both speed and precision over the usual method employing visual criteria and tests of breaking resistance for evaluating amounts of decay in small stakes.

Results

Results of the tests made on basal heartwood of the 34 sampled trees are summarized in Table 1. For material comparably exposed to decay, the indicated decay resistance is, of course, greater as the weight loss is smaller. From the average weight losses, it will be noted that considerably more decay occurred in the laboratory tests than in the stake tests, and that in the stake tests much more decay occurred in Plot 1 than on plots 2 and 3. Inasmuch as nominally matched wood was present in all cases, corresponding specimens should have had about the same inherent susceptibility to decay. It is clear, therefore, that the weight losses have significance more as relative than as absolute measures of decay resistance, and that for evidence of relative decay resistance weight losses can be compared only within the same test or within groups of tests of similar decay hazard.

Relative Decay Resistance of Second-Growth and Virgin-Growth Douglas-Fir

In an earlier but comparable laboratory test, the outer heartwood of seven virgin, coast type Douglas-fir trees incurred an average weight loss of 33 percent. The corresponding loss in the outer heartwood of the 34 second-growth firs was 28 percent. In the present stake tests, nominally matched outer heartwood from five of the virgin trees incurred an average weight loss of 9, 5, and 5 percent, respectively, on Plots 1, 2, and 3, and corresponding losses in the second-growth outer heartwood were 12, 6, and 5 percent. This limited evidence indicates that wood of second-growth Douglas-fir is little if at all inferior in decay resistance to that of virgin-growth timber.

By way of further orientation, it may be added that among native woods of commercial importance, Douglas-fir might be regarded as moderately decay resistant in contact with the ground. For example, as fence posts it is reported to have a service life of approximately 5 to 10 years, whereas comparably situated posts of woods rated as resistant last 10 to 15 years and very resistant woods last substantially longer (*2, 4, 13*).

TABLE 1.—DESCRIPTION OF BOLTS TAKEN AT A HEIGHT OF 6 TO 8 FEET IN SECOND-GROWTH DOUGLAS-FIR TREES AND WEIGHT LOSSES CAUSED BY DECAY IN SPECIMENS FROM THESE BOLTS

Observation		Site II (17 trees)			Site IV (17 trees)		
		Range		Average	Range		Average
Sapwood thickness (inches)		0.9	2.2	1.5	0.5	2.0	1.0
Heartwood diameter (inches)		9.9	25.0	16.1	6.7	16.5	11.8
Number of growth rings in the heartwood		46	77	60	70	108	90
Number of rings per inch							
	Outer heartwood	8	18	13	18	36	23
	Middle heartwood	5	9	7	10	30	15
	Inner heartwood	3	6	5	6	21	10
Percentage of summerwood							
	Outer heartwood	30	45	37	34	42	37
	Middle heartwood	22	35	29	28	39	34
	Inner heartwood	19	30	24	21	32	28
Specific gravity							
	Outer heartwood	.48	.58	.53	.51	.63	.56
	Middle heartwood	.40	.53	.46	.48	.57	.52
	Inner heartwood	.37	.52	.43	.41	.52	.47
Percentage weight loss[1] produced by decay in: stake tests							
Plot 1 (Pine woods)	Outer heartwood	6	19	13	5	23	12
	Middle heartwood	8	28	18	8	24	16
	Inner heartwood	9	37	20	8	36	17
Plot 2 (Oak woods)	Outer heartwood	1	16	7	3	17	6
	Middle heartwood	4	23	9	3	19	7
	Inner heartwood	2	15	8	3	13	6
Plot 3 (Prairie)	Outer heartwood	1	10	5	2	8	5
	Middle heartwood	2	17	6	2	13	6
	Inner heartwood	2	17	6	2	20	6
All plots: Corresponding bolt values averaged	Outer heartwood	4	14	8	5	16	8
	Middle heartwood	5	22	11	5	20	10
	Inner heartwood	5	18	12	6	15	10
Laboratory tests (Average results for all 6 test fungi)	Outer heartwood	23	37	28	16	33	28
	Middle heartwood	24	37	29	24	35	29
	Inner heartwood	28	35	30	23	35	30

[1]Each weight loss value is based on tests of 4 to 8 stakes per radial position and tree, or, in the case of the laboratory tests, on tests of 24 blocks (4 blocks per fungus) per position and tree.

Relation of Decay Resistance to Growing Site

The tests uniformly indicated practically the same level of decay resistance for the wood from Sites II and IV. Moreover, this equality appeared to be virtually independent of difference between the two sites in measurable physical characteristics of the trees or wood. It is unlikely, therefore, that the decay resistance of second-growth Douglas-fir is directly influenced by the growing site. Correlation analysis of the laboratory results indicated that with trees of the same age the resistance of the outer heartwood (comprising more than half the heartwood volume) may be slightly greater in larger trees than in smaller trees, and with trees of the same diameter it may be slightly greater in older than in younger trees. Thus the quality of the growing site as it determines tree size and size relations may influence the decay resistance in an indirect way. But the matter is not of practical interest in this case, because the differences in resistance related to tree size and age were very slight.

Relation of Decay Resistance to Physical Properties of the Wood

Decay resistance was found to be similarly related to other factors; but in these cases also the associated differences were slight and are here reported mainly for completeness of the record and for the academic interest attached.

The resistance of the heartwood from the same growing site tended to be slightly greater as the number of growth rings per inch, the percentage of summerwood, and the specific gravity were greater. These relations seem to be attributable largely to a variation in resistance according to the radial position of the wood within individual trees, as will be noted further on, rather than to any specific effect of the physical characters themselves. The relation between decay resistance of all specimens from both Sites II and IV and specific gravity (in this connection only the laboratory results were analyzed in detail) can be expressed by a correlation coefficient of —0.276. This coefficient, although here highly significant statistically, indicates that less than 10 percent of the observed variation in decay resistance might be accounted for by the variation in specific gravity of the wood. The association between decay resistance and rings per inch and percentage of summerwood appeared to be even slighter.

Variation in Decay Resistance Among Trees

As indicated by the ranges in weight-loss shown in Table 1, there were sizeable differences in amounts of decay in wood from different trees. A considerable part of this variation was caused by uncontrollable factors of the testing. For example, in the stake tests, where the variation was greatest in proportion to the average amounts of decay, it was found that several decay fungi were attacking. Nevertheless, similarities in relative amounts of decay in the different test series showed that a portion of the larger differences represents real differences in decay resistance. A few trees consistently exhibited substantially more than moderate decay resistance and fully as many exhibited a low level of resistance. As they could not be accounted for by differences in the environment or character of the trees or in the physical characteristics of the wood, these real differences in resistance among trees are regarded as hereditary features.

Variation in Decay Resistance Within Trees

The outer heartwood of individual trees tended to be a little more resistant to decay than the inner heartwood. This difference was shown by the stake tests for 85 percent of the trees, and by the laboratory tests for 32 to 88 percent of the trees, depending upon the test fungus used. A similar radial trend in decay resistance has been found in other species, the differences in some instances being comparatively large. Usually the resistance of the middle heartwood is intermediate between that of the outer and inner heartwood.

As already mentioned, the radial position of the wood in the trunk probably accounts for more of the radial variation in decay resistance observed in the second-growth Douglas-fir than do the correlated physical characteristics of the wood mentioned in a preceding section (eg. specific gravity, rings per inch, percentage of summerwood). This is suggested by findings with white oak (*12*) and black locust (*11*), in which any influence by specific gravity on decay resistance was largely overshadowed by the factors of radial position and tree size and age.

In the six trees assayed for differences in decay resistance longitudinally in the trunk, there was no evidence of a relationship between resistance and height of the wood above the ground. The uppermost trunk positions tested in this connection were at heights of 66 to 106 feet.

Field Results as Affected by Testing Site

Because of the current widespread interest in accelerated testing of decay resistance in the field, the following observations are reported even though they do not alter the foregoing picture of decay resistance. Similar observations are needed to strengthen field testing procedures and to enable more practical interpretation of the results.

It has already been noted that decay on Plot 1 (pine woods) was much greater than that on Plots 2 (oak woods) and 3 (prairie). Amounts on Plots 2 and 3 were about the same. The explanation for the more rapid decay on Plot 1 is obscure. White-rot fungi were the predominant cause of decay on all three plots. These were more prevalent in the stakes in Plot 1 (85 percent) than in the others (54 and 70 percent, respectively, for Plots 2 and 3), but decay by brown-rot fungi would be expected to make the more rapid attack on Douglas-fir. It is tentatively concluded that the species of white rotters differed in frequency, if not in kind, on the different plots and that the proportion of species most able to decay the Douglas-fir was greatest on Plot 1, or that the top soil of Plot 1 was the most favor-

able one for promoting attack on the wood. The depth of top soil (1 to 1.5 inches) in that plot was only about a third of that in the other plots. It may be significant, however, that this top soil was considerably the richest of all in organic matter, total nitrogen, and available phosphorus pentoxide.[2] Soil temperatures from spring to fall were the most suitable for decay on Plot 3. Observed differences in moisture content of the test stakes on the different plots were negligible.

Absolute amounts of decay on different sites are of interest mainly where estimates of actual service life of a given kind of wood on particular areas are wanted. They are of secondary interest in tests like the present ones, where the *relative* order of decay resistance of different woods is the information primarily sought. It follows that it also is important to know whether this relative order of resistance is likely to be the same on areas of dissimilar character.

In spite of the marked diversity of test sites and differences in decay intensity among Plots 1, 2, and 3, about the same relative order of decay resistance was indicated for the specimens on each of the three plots. The similarity of order of decay resistance was ascertained by analysis of variance of the weight losses, which disclosed that there was no significant "interaction" between weight loss and test plot among the different samples of wood.

No formal check was made for the degree of correspondence between results of the field and laboratory tests. Substantial correspondence as to effect of site and radial position is indicated in Table 1.

[2]Proximate analyses of the soils were made by the Department of Soils, University of Wisconsin, under the direction of Dr. S. A. Wilde.

Summary

As one phase of a broad study of the characteristics of coast-type, second-growth Douglas-fir wood, an appraisal was made of its decay resistance. Tests were made in the laboratory with small blocks and in the field with small stakes; the field tests were replicated on three different plots of diverse character with respect to vegetative cover. Heartwood from 34 trees was used; half the trees were on an area of Site Quality II and half were on an area of Site Quality IV. The stands were fully stocked and about 100 (Site II) to 150 (Site IV) years old.

The decay resistance for the most part was indicated to be what might be regarded as moderate, but not inferior to that of virgin-growth Douglas-fir wood. A few trees exhibited substantially better than moderate resistance and a few exhibited a low order of resistance. The larger differences in resistance appeared to be of genetic origin. The average resistance of wood from the two growing sites was the same. There was evidence of a slight tendency for the decay resistance to vary with the size and age of the trees, and with the radial position and associated physical characteristics of the wood in individual trees. The trends were of no practical significance, however.

The same relative order of decay resistance among specimens was indicated by the results obtained on each of the three field test plots. The average amount of decay on one plot, on the other hand, was much greater than on the other two. The significance of these results is discussed.

At least with respect to growing site and radial position of the wood in the tree, the same relative order of decay resistance among specimens also was indicated by both laboratory tests and field tests.

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Response of Loblolly Pine to Thinning

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How and when should loblolly pine be thinned? This study suggests that thinning practices best suited to sawlog production are not necessarily the most profitable where pulpwood is the main objective.

ON LARGE ACREAGES of old fields and cutover areas in the South, even-aged loblolly pine forests have established themselves and grown to the stage where foresters must decide how and when to thin them. This article, which reports on one of the oldest loblolly thinning studies west of the Mississippi River, suggests that thinning prescriptions will vary with the kind of product the owner wants to grow, and that forest managers must have a clear picture of what they want before they send out markers and saw crews.

The Maxwell Study

The five plots described here comprise the Maxwell thinning study, conducted at Urania, in central Louisiana, by the U. S. Forest Service and the Urania Lumber Company. Results on other plots at Urania bear out the findings of the Maxwell study, but will not be discussed here.

Average site index for loblolly pine on the Maxwell plots is 93. The plots, each a quarter-acre in size, represent four different thinning treatments and an unthinned check. The stand originated in 1907 on an old field. Plots U-3 and U-5 were established in 1915, when the stand was 8 years old. Plot U-3, the check plot, has never been thinned. Plot U-5 was the first thinned at age 8 and has been thinned lightly at 5- and 10-year intervals thereafter as the stand closed in. The first two thinnings were non-revenue producing, since the trees removed were too small for merchantable pulpwood. In general, thinnings have been from below, although rough and deformed trees in the larger crown classes have also been cut.

Plots U-54, U-55, and U-56 were installed and first thinned in 1925, when the trees were 18 years old and large enough for pulpwood. Plot U-54 was thinned very heavily; only 100 of the largest and best dominant and codominant trees were left per acre. Additional thinnings were not needed until 1951. The purpose of this treatment was to compare the diameter and volume growth from a very heavy thinning, leaving approximately the number of trees expected in the final crop of sawlog-size trees, with that from lighter thinnings made at periodic intervals.

The original thinning on plots U-55 and U-56 removed chiefly rough and deformed dominants and codominants plus smaller merchantable-size trees apt to die from suppression. Later thinnings removed mostly codominant and intermediate trees. The main difference in treatment on these two plots was that U-55 was consistently thinned more heavily than U-56.

More detailed information on original stand conditions and intensity of thinnings is given in Table 1.

Volume Growth

Up to 1940, when the stands were 33 years old, periodic annual cordwood growth was greater on the unthinned check plot than on any of the thinned plots (Table 2). From 1915 to 1925, annual growth averaged 2.4 standard cords per acre on the check plot as against 2.3 standard cords on the early thinning plot (U-5). Over the next 15 years, periodic annual growth was 2.4 standard cords per acre on the check plot, 2.2 on the early light thinning from below, 2.0 on the deferred light thinning from above (U-56), 1.9 on the deferred heavy thinning from above (U-55), and 1.2 on the crop-tree thinning (U-54). After age 33, heavy mortality in the merchantable size classes sharply reduced cordwood growth on the check plot below that on all of the thinned plots.

Up to 1940, or age 33, cordwood growth was greatest in plots with the heaviest average residual basal areas. Even the light thinnings reduced growth below that on the check plot, but not so much as did the heavy thinnings. This same relationship was found beyond age 33 on the thinned plots. It clearly indicates that when maximum cubic-foot growth is desired on a long rotation, thinnings should be very light, removing mainly trees that are likely to die of suppression in the next few years, or that are defective and deformed. Moreover, these data indicate that stands that are unthinned or thinned very lightly to anticipate mortality will grow the most pulpwood on a short rotation.

Prior to 1940, nearly 5 cords of wood in merchantable-size trees were lost on the check plot through mortality. It might be deemed advisable to salvage such material just before the trees die even though cordwood growth on the check plot was superior to that on the thinned plots. However, the costs of marking and supervision, the reaction of contractors to cutting small trees almost exclusively, and the logging damage to the residual stand may make thinning undesirable, particularly where heavy cuts per acre are required to make logging commercially feasible.

Cordwood growth was greater on the plot given two pre-commercial thinnings than on the deferred thinning plots, but these differences are probably due to stocking of the stands rather than to the thinning treatment. Non-revenue thinnings are generally unnecessary in loblolly pine stands, as the trees usually express dominance early in life. Occasionally loblolly on very poor sites such as eroded fields becomes stagnated, and then a non-revenue thinning may be beneficial.

Diameter Growth

In contrast to volume growth, diameter growth generally has been best where thinnings were heaviest (to avoid the fluctuations in stocking that are caused by cutting and mortality). Table 2 shows diameter growth in terms of the 100 largest trees per acre). However, not even the heaviest thinnings showed a consistent growth rate of 3 inches in 10 years. This goal was nearly reached by the heavy deferred thinning, but lack of thinning in the last 10 years caused diameter growth to decline from 1946 to 1951. Experience shows that very heavy periodic thinnings are required to obtain a growth rate close to 6 rings to the inch.

Either because they were too light or too early, the two early thinnings on plot U-5 did not stimulate diameter growth above that on the check plot. This is another indication that pre-commercial thinnings are seldom needed or justified.

The check plot furnishes a good clue as to when the first thinning should be made when the objective of management is large products on a long rotation. From 1915 to 1925, diameter growth on the check plot exceeded that on the plot lightly thinned from below, and during 1925 to 1930 it equalled or exceeded the growth on all thinned plots except the crop-tree thinning. During the next 5-year period (1930-35), however, diameter growth was less on the check plot than on any of the thinned plots. This drop in diameter growth coincided with the beginning of heavy mortality of merchantable-size trees. Indications are that the first thinning should have been made about age 23, just before the period of heavy mortality and reduced diameter growth. The beginning of mortality of 4- and 5-inch trees from suppression should serve as a good signal to make the first thinning in most stands.

The crop-tree thinning was unprofitable in all respects. Not only was cordwood growth drastically reduced by the heavy thinning treatment, but the very fast diameter growth which followed the initial thinning steadily decreased. In the period 1935-1940, diameter growth was less than on any of the other thinned plots. From 1925 to 1930, average annual diameter growth was 0.42 inch, but during the last 5 years it was only 0.16 inch—less than that on the check plot for the same period. Over the 26-year period 1925-1951, average diameter growth on the crop-tree thinning plot was about the same as on the periodically thinned plots. While a second thinning in 1935 might have accelerated diameter growth, or at least staved off further decline, the basal area of

TABLE 1.—LOBLOLLY PINE STAND AND STOCK DATA PER ACRE ON THE MAXWELL THINNING PLOTS

Period	Age at start of period	Pines[1]			Basal area[1]			Merchantable volume[2]		
		Cut at start	Left at start	Living at end	Cut at start	Left at start	Living at end	Cut at start	Left at start	Living at end
	Years	*Number*			*Square feet*			*Standard rough cords*		
Plot U-3—Unthinned										
1915-20	8	—	1,328	1,280	—	16.5	94.4	—	0.0	7.5
1920-25	13	—	1,280	816	—	94.4	134.2	—	7.5	24.4
1925-30	18	—	816	600	—	134.2	155.7	—	24.4	36.9
1930-35	23	—	600	476	—	155.7	166.4	—	36.9	49.7
1935-40	28	—	476	396	—	166.4	174.1	—	49.7	59.7
1940-46	33	—	356	288	—	174.1	168.5	—	59.7	64.5
1946-51	39	—	288	232	—	168.5	164.7	—	64.5	64.6
Plot U-5—Early light thinning from below										
1915-20	8	688	1,144	1,416	2.3	15.8	99.3	0.0	.0	6.5
1920-25	15	160	1,256	892	7.1	92.2	138.4	.2	6.3	22.6
1925-30	18	468	424	388	45.4	53.0	121.2	5.1	17.5	28.8
1930-35	23	68	320	320	15.3	105.9	132.1	3.4	25.4	37.2
1935-40	28	88	232	220	34.1	98.0	116.2	9.7	27.5	36.8
1940-46	33	0	225	216	—	116.2	138.9	.0	36.8	50.0
1946-51	39	108	108	108	50.0	88.9	108.4	17.4	32.6	42.6
Plot U-54—Crop-tree thinning										
1925-30	18	664	100	96	100.9	30.6	48.5	17.4	6.3	11.4
1930-35	23	0	96	96	—	48.5	65.5	—	11.4	18.5
1935-40	28	0	96	92	—	65.5	76.8	—	18.5	24.9
1940-46	33	0	92	92	—	76.8	92.0	—	24.9	33.1
1946-51	39	0	92	92	—	92.0	102.4	—	33.1	41.6
Plot U-55—Deferred heavy thinning from above										
1925-30	18	296	488	432	43.0	84.0	107.4	6.6	15.5	24.4
1930-35	25	144	288	240	25.1	82.3	100.8	4.9	19.5	29.9
1935-40	28	84	156	136	38.8	62.0	78.7	11.8	18.1	26.7
1940-46	33	0	136	124	—	78.7	99.3	.0	26.7	35.6
1946-51	39	0	124	120	—	99.3	112.2	.0	35.6	45.6
Plot U-56—Deferred light thinning from above										
1925-30	18	476	772	640	49.5	89.6	116.0	5.2	13.0	23.0
1930-35	23	144	496	416	20.2	95.8	115.6	2.9	20.1	31.5
1935-40	28	108	308	256	35.4	80.2	96.9	10.3	21.2	30.5
1940-46	33	0	256	200	—	96.9	111.5	.0	30.5	40.1
1946-51	39	48	152	152	15.7	95.8	114.8	3.9	36.2	45.6

[1]Including trees larger than ½ inch in d.b.h.
[2]Including trees larger than 4½ inches in d.b.h.

65.5 square feet per acre at that time suggests that a thinning was not needed. Moreover, if a thinning had been made in 1935, it probably would have reduced cordwood growth further.

Sawlog Growth and Quality

In the last 5 years, average annual saw-timber increment was 634 board feet per acre (International ¼-inch rule) on the early light thinning, 476 feet on the deferred heavy thinning, 444 feet on the crop-tree thinning, 346 on the check plot, and 221 on the deferred light thinning. It is too early, however, to attach any significance to differences in sawlog volume growth, because heavy ingrowth is still occurring in all stands.

Although the stands are still too young to have many top-quality sawlogs, indications are that thinning from above will produce the best grade yields. Table 3 gives the board-foot volume of all trees over 9.5 inches in d.b.h. by Crossett log grades.[1] Both of the thinnings from above have so far produced about 50 percent more Grade 2 logs than the thinning from below. In fact, the check plot has produced more Grade 2 logs than either the crop-tree thinning or the light thinning from below.

Quality development has been poorest on the plot originally thinned back to 100 crop trees per acre. Here only 12 percent of the sawlog volume now is Grade 2.

When thinning from above to increase quality, it is by no means necessary to remove all dominant trees. Some dominants will be very clean and well worth saving. Similarly, thinning primarily from above will be necessary only for the first two or three thinnings, or until the rough and deformed dominants have been entirely removed from the stand. After that, thinnings should be made primarily from below, and should be designed to give ample growing space to the selected crop trees and to salvage anticipated mortality.

Other studies bear out the conclusion that initial thinning from above is preferable to thinning from below if quality is an objective. Two or three thinnings from above, however, will result in a somewhat lower average diameter than if thinning from below were practiced continuously.

[1]Reynolds, R. R., W. E. Bond, and B. P. Kirkland. Financial aspects of selective cutting in the management of second-growth pine-hardwood forests west of the Mississippi River. U. S. Dept. of Agric. Tech. Bul. 861. Pp. 43-45. 1944.

TABLE 2.—PERIODIC ANNUAL CORDWOOD GROWTH OF ALL LOBLOLLY PINE TREES, AND DIAMETER GROWTH OF THE 100 LARGEST LOBLOLLY PINE TREES PER ACRE, 1915 TO 1951

Age at start of period	Average basal area per acre[2]	Periodic annual net volume growth[3]	Periodic annual mortality[3]	Periodic annual diameter growth[3]
Years	*Square feet*	*Standard rough cords*		*Inches*
		Plot U-3—Unthinned		
8	55.4	1.50	0.00	0.64
13	114.3	3.38	.00	.38
18	145.0	2.50	.06	.28
23	161.0	2.56	.40	.20
28	170.2	2.00	.58	.22
33	171.3	.80	1.50	.17
39	166.6	.02	1.48	.18
		Plot U-5—Early light thinning from below		
8	57.6	1.30	.00	.62
13	115.3	3.26	.00	.34
18	107.1	2.26	.14	.28
23	119.0	2.36	.00	.22
28	107.1	1.86	.12	.26
33	127.6	2.20	.18	.23
39	98.6	2.00	.00	.26
		Plot U-51—Crop-tree thinning		
18	39.6	1.02	.02	.42
23	57.0	1.42	.00	.32
28	71.2	1.28	.12	.24
33	84.4	1.37	.00	.18
39	97.2	1.70	.00	.16
		Plot U-55—Deferred heavy thinning from above		
18	95.7	1.78	.02	.28
23	91.6	2.08	.00	.26
28	70.4	1.72	.00	.26
33	89.0	1.48	.00	.27
39	105.8	2.00	.06	.18
		Plot U-56—Deferred light thinning from above		
18	102.8	2.00	.00	.26
23	105.7	2.28	.08	.24
28	88.6	1.86	.02	.26
33	104.2	1.60	.40	.20
39	105.3	1.88	.00	.20

[1]Including trees larger than ½ inch in d.b.h.
[2]Including trees larger than 4½ inches in d.b.h.
[3]Including only 100 largest trees per acre.

TABLE 3.—QUALITY AND VOLUME OF LOBLOLLY PINE SAWLOGS PRODUCED PER ACRE BY 1951

Treatment	Sawlog volume by Crossett log grade				Proportion of volume by Crossett log grade	
	Grade 1	Grade 2	Grade 3	Total	Grade 2	Grade 3
	Bd ft. (Int. ¼ inch rule)				*Percent*	
Unthinned (U-3)	0	4,960	12,580	17,540	28	72
Early light thinning from below (U-5)	0	3,700	12,880	16,580	22	78
Crop-tree thinning (U-54)	0	1,900	14,000	15,900	12	88
Deferred heavy thinning from above (U-55)	0	5,290	11,030	16,320	32	68
Deferred light thinning from above (U-56)	0	5,780	7,230	13,010	44	56

Conclusions

For a pulpwood rotation up to about 35 years, unthinned loblolly stands seem to have the best cordwood growth. This means that early returns are sacrificed for maximum production. Where early returns are needed, light thinnings, made mainly by removing suppressed trees, are indicated, pro-

vided that logging damage or expense is not excessive.

Landowners desiring maximum production of pulpwood and sawlogs per acre will favor light thinnings which keep the stand just open enough to prevent mortality from suppression and excessive shortening of live crowns. Light thinnings will result in a somewhat slower rate of diameter growth than heavy thinnings, thus deferring somewhat the time when products of a specified size can be harvested. Rotations can be shortened by making heavy thinnings to promote rapid diameter growth, but this will result in lowered total cubic-foot yields.

Probably most landowners will prefer the middle course, where moderate thinnings are made to promote fairly fast diameter growth with some reduction in total yield of the stand. Within reasonable limits, the dollar returns from all degrees of thinnings will be comparable over a rotation if it is assumed that all returns from thinnings are invested at 3 percent compound interest.

Vegetable Aliment From Wood[1]

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AN ALIMENT is a nourishing substance. The word is used in its old meaning in order to bring out (right at the beginning) that this is an old story. The reason and purpose for presenting it are that the story has modern sequences and importances which merit greater attention than they have found.

Fields and Forests

The supply of food for a rapidly growing world population has formerly, and again now, caused deep concern in many circles. The "possibilities of meeting the world's food needs" were discussed at a recent symposium under the auspices of the American Association for the Advancement of Science (*1*). Can our "plundered planet" continue to produce the necessary crops, in quantity and quality, to feed more and more people? In this country, agriculture produces increasing crops. Careful breeding and selecting of seeds, and large industrial production of mineral nutrients and farm machinery achieve great results. We can thus offset the continuing losses of good topsoil. Many other countries are not so fortunate. The question arises whether the products from cultivated fields could be amplified by products from the forests.

This is an old question. Without waiting for a precise answer to it, people have resorted to wood, bark, leaves, and acorns provided by the forest to obtain food in times of distress. The beginning of the 19th century saw serious attempts to find methods by which really nourishing materials could be derived from wood, if not for humans, at least for domestic animals. These methods soon branched out in two directions. One of them consisted in converting the cellulose of wood by hydrolysis into water-soluble carbohydrates. After decades of scientific and engineering developments, commercial production of sugars, proteins, and alcohols has been achieved. Such production was important during World War II, and is continuing in Germany, Finland, Russia, and Switzerland. The other direction was the immediate conversion of the wood substance into digestible material. After an enthusiastic start in the beginning of the last century, methods were slowly investigated and their products tested. They were used during the war. While the conversion by deep-reaching hydrolysis has become a part of our technology, the other conversion still appears like an outgrowth of a last resort. Both directions may still have a considerable future.

The history of wood hydrolysis is well known. Numerous laboratory procedures, beginning with Braconnot in 1819, and technical proposals preceded the concentrated work on industrial methods which started during the World War I and resulted in two different processes around 1930. A critical survey of this development was published at about that time, with emphasis on the physico-chemical aspects and, therefore, included in a volume devoted to progress in applied physical chemistry (*2*). The story of the direct conversion of wood into what was called "vegetable aliment" over a century ago has not found a similar degree of attention. Part of this story is hidden in old literature, another part in more recent patents.

The Pre-chemical Period

Many old reports mention the use of wood in bread during times of drought and widespread hunger. The Italian prelate, Giovanni Battista Segni (about 1550-1610, Ferrara), described a treatment of acorns which makes them palatable by removing bitterness. "For the poor and miserable people, so that they can nourish themselves at little expense and keep themselves alive," he recommends an admixture of wood.

"One can make bread from the fine sawdust of young trees, such as pear trees, cherry trees, and their barks, after they have been dried in the oven and pulverized. One takes as much of this powder as of prepared dog-grass, and the same amount of groats, and a kettle full of pulverized turnips, all this passed through the sieve with fennel, after all this has been fermented. This bread is very good when cooked for the sustenance of

[1]Paper presented at the 116th meeting of the American Chemical Society, Atlantic City, N. J., September 19, 1949.

the poor." (*23*).

Bark was often used, not on the basis of a known food value, but because it was easy to strip it from trees and to grind it. Macquer's famous "chemical dictionary," which contains an unhurried discussion of the chemical problems right at the time of the change from the phlogiston theory to the oxygen system, has a long article on bread with the following footnote by J. G. Leonhardi (*17*).

> In addition to the seeds of cereals, bread is baked in several countries with roots, bark and marc of some plants and trees, as well as with some kinds of moss.

No proof is offered that wood contributes to the food value of such mixtures. Sometimes anything which had the form of a fine powder was considered equivalent to bread flour. The addition of flours from finely ground lime or gypsum could be definitely rejected when flour from grain was at least characterized as being fermentable (*18*).

Saccharine Principle and Vegetable Aliment

Fermentation and the chemical nature of sugar began to be chemically understood at the time when the chemistry of water and oxidation were seen in the new light of the oxygen theory. Lavoisier (1789) theorized that plant life is based on a general process in which water is decomposed. In this process, the oxygen of water is released to the atmosphere, the hydrogen is retained to form the combustible part of plant substances. Fermentation, according to Lavoisier, results in a redistribution of oxygen in sugar, which is thus revealed as a chemical combination of carbon, hydrogen, and oxygen. Quantitative analysis led William Prout (1827) to declare saccharine principles as those "into the composition of which the hydrogen and oxygen enter in the proportions in which they form water." In the article which contains a description of his method of analysis by combustion, he comes to the following conclusion: "Saccharine principle and vegetable aliment may be regarded as synonymous terms." (*21*).

A few years before Prout's publication, Braconnot had made glucose from wood after treating it with concentrated sulfuric acid. A little earlier still, the professor of medicine at Tubingen, J. H. F. von Autenrieth (1772-1835) had published a "thorough prescription on preparing bread from wood." (*25*). W. Prout reports enthusiastically about this book. By extracting wood with water, boiling, reducing it to "actual powder," heating in the oven and again grinding to flour, a bread as tasty as if it were made from corn can be obtained. "Wood flour also, boiled in water, forms a thick, tough, trembling jelly like that of wheat starch, and is very nutritious."

Berzelius also refers to Autenrieth, but in a considerably more reserved manner. In his textbook of chemistry, which he began to write at the age of 28 (1807) and of which a fifth edition was completed after his death (1848), he said: "The application of wood is generally known. The future will demonstrate whether sugar and gum can advantageously be made from it. Autenrieth reported a few years ago that finely dispersed sawdust, made coherent with very little flour and formed into cake, could be used with advantage as a fodder for pigs, and he claims to have fattened them with it. The correctness of this claim, which is not unimportant for agriculture, has not been confirmed as yet. In this case, one should suppose that the digesting organs of animals change the composition of wood in the same manner that sulfuric acid does." (*3*).

Years went by and no confirmation appeared. On the contrary, J. R. Wagner, professor of technology at the University of Wurzburg, and editor of the famous annual progress reports on chemical technology (since 1855), in 1860 very definitely stated with regard to bread: ". . . bark, wood, straw, paper, in part also lichen, which have now and then been proposed, all these substances undoubtedly deserve not the slightest attention." (*26*). He adds that in Sweden and in Norway, bark from spruce trees is used for baking. The preparation of the bark consists in leaching with flowing water for 14 days, drying and pulverizing. Bread is made from two-thirds of this bark material, and one-third of rye flour.

The shortage of grains repeatedly forced people to fall back on food from trees. During a great famine in Hungary in 1863, it was suggested to use leaves and twigs (*30*). These parts of the tree offered the additional advantage of containing proteins. Julius Sachs had just demonstrated (1862) that the assimilating leaf is rich in this vital material.

Early Patents

The conversion of wood into animal feed is described in several patents of 1884 and later. J. W. Wendenburg, of Stolpe, Prussia, claimed in these patents that fodder can be prepared by pulverizing wood, particularly beech, birch, and acacia (locust), mixing it with salt and adding distillery slops (*28*).

An improvement consists in treating the wood powder with 1/8 percent sulfuric acid in hot water for 6 hours. Better baking qualities result from the addition of lime and of slops from malted potatoes (*29*).

It could not be established whether these inventive efforts have led to applications on a large scale. The efforts were continued, about 25 years later, with the important, although not successful, improvement which consisted in a more thorough pre-treatment of the wood.

The method was an outgrowth of the many attempts to produce sugar from wood. G. F. Melsens (*19*) and Dauziville (*6*) tried to achieve this with hydrochloric acid, E. Flechsig (*10*) with concentrated sulfuric acid, Alexander Classen (*4*) with dilute sulfurous acid.

Dilute acids give only small yields of soluble sugars but, as John K. George (*11*) claimed, the residual wood is digestible. By mixing it with molasses, he produced what he described as "a readily assimilated product in which the sugars contained in the saccharine

matter, cellulose and molasses, differ chemically."

Instead of molasses, the concentrated wood-sugar solution is added to the residual wood according to T. B. Walker (*27*).

Digestibility Tests

While wood was prepared by grinding with water and cooking with acids, straw was cooked with alkali to make it more digestible. It seems strange that no influence radiated from one of these fields to the other.

Otto Kellner, the dean of German agriculturists in his time, reported in 1900 in the journal of the agricultural research stations of Germany on extensive tests for digestibility of straw (*16*). He cooked rye straw with about twice its weight of a solution which contained, per liter, 55 grams caustic soda, 20 grams sodium carbonate, 22 grams sodium sulphide, and a little sodium chromate. The mixture was heated to a temperature corresponding to 7 atmospheres (about 100 p.s.i.) pressure and kept there for 3½ hours.

In discussing Kellner's results, C. F. Cross and E. J. Bevan tried to explain the fact that untreated straws are less digested than the treated ones. These two English researchers, who contributed much to the foundation of modern chemistry of cellulose, sought a simple model with which straw could be compared. "We may regard a lignocellulose, as in the straw substance, as a species of ester, and the action of the alkaline mixture used for 'pulping' the straw as a saponification with secondary actions due to the sulphides. . . ."(*5*).

The separating action which alkali exerts upon lignocellulose is not sufficient proof for its being an ester, as many investigators pointed out against Cross and Bevan. Whether by chemical bond, or by physical adsorption (Wislicenus), lignin reduces the digestibility of cellulose. Should the nutritive value of trees be sought in their starch and fat content? A. Fischer (*9*) spoke of starch trees and fat trees, the former mainly hardwoods, the latter softwoods, and G. Haberland (*12*) in the early part of the first world war, revived the emphasis on these nutritive cell-contents. They have to be made accessible to the digestive juices by tearing open each single cell. This can be done by a combination of mechanical with chemical action. Sawdust still contains too many intact cells. After treating it with hydrochloric acid, drying and then grinding it, Carl G. Schwalbe found he could make wood digestible as good hay. A plant was hastily erected near Suwalki, Poland, after it had been occupied by the German army in 1915. Many difficulties arose. The green sawdust clogged up in the conveyors, more water had to be added, and this made it necessary to increase drying capacity. When the plant was ready for operation, horses had become too valuable for experimental feeding, particularly since some adverse results had been obtained. Were they caused by insufficient evaporation of furfural? Before this could be found out, the plant burned down.

At least it could be established that the treated wood gave a slimy material when used directly for wet grinding. Wood washed before grinding did not swell but gave a powder which dried to a porous mass. This difference in colloidal behavior was attributed to the presence of glucose in the treated wood. Lactic acid had a similar hydrating effect. Ruminants utilized the raw fiber in the colloidized wood with an efficiency of 63 to 77 percent (*22*).

A mixture of leaves and twigs, mainly from beech and birch, formed into cakes with grass and molasses, was actually fed to heavy horses during the war of 1914-18. Very soon, however, not enough of even this surrogate was available (*7*).

For cellulose obtained by cooking wood either with calcium bisulfite or with alkali, G. Fingerling, director of the agricultural research station connected with the University of Leipzig, showed high digestibility. Sheep utilized 75 percent of the organic matter and 92 percent of the "raw fiber" of coarse cellulose, and even more of fine cellulose fibers (*8*).

Continued Efforts

Wood did not supply much food or fodder during the 1914-18 period. Direct conversion of wood by combined partial hydrolysis and fine grinding did not have sufficient technical and physiological foundation. Complete hydrolysis of the cellulose was started in 1916, but it was far from ready for technical application even long after the end of the war. The problem of utilizing wood waste for the production of "vegetable aliment" remained unsolved, but it was not abandoned. Cellulose is so closely related to starch, and both are so prevalent in natural foodstuffs, that it was thought it should be possible to impart sufficient digestibility to wood. The complete hydrolysis to water-soluble sugars was one way to this goal, but not the most desirable one, both from technical and physiological considerations. E. C. Sherrard again proposed the partial hydrolysis by dilute acids combined with the return of the sugar solution, in concentrated form, to the great bulk of residual wood (*24*). A really colloidal dispersion of wood, first promoted by H. Plauson (*25*) was later claimed by F. Haffner and H. Schlechter as a method for making it digestible (*13*).

During World War II wood cellulose accumulated in Sweden because exports were cut off. Since foodstuffs became scarce, this cellulose was used as stock feed. It was too expensive for more normal times and abandoned at the close of the war.

Recent investigations have established that "pigs are able to digest non-lignified cellulose with an efficiency not far short of that displayed by huminants. The most startling difference in this respect between the ruminant and the pig is that the latter makes much poorer use of cellulose in its lignified form." (*31*).

Conclusions

The sawdust which Segni recommended as an economical addition

to bread for the poor was certainly not greatly enhanced in nutritive value by simple kitchen procedures. More is necessary to make wood digestible, but perhaps not quite as much as is done by hydrolysis. Molasses of good digestibility can be made from the carbohydrates of hydrolyzed wood (*14*). The intermediate form, a hydrated cellulose compound which is digested by many animals, should be of great interest. We need to know more about this intermediate form. Perhaps further work will have to make a selection between species of wood, some of which should be more readily converted than others. The biochemical and physiological significance of lignification is another field to which the foregoing historical facts may invite further investigations. Thus, while most of the early claims are without foundation, the subsequent developments justify the statement which J. F. W. Herchel made in 1831 concerning Autenrieth's and Prout's reports. It is contained in an Encyclopedia article which was also published in book form. "This discovery which renders famine next to impossible deserves a higher degree of celebrity than it has obtained" (*15*).

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North Carolina State College Enlarges Pulp and Paper Work

Appointment of Prof. Clarence Earl Libby of Syracuse, N. Y., to head the curriculum in pulp and paper technology in the School of Forestry at North Carolina State College has been announced by Dean Richard J. Preston, Jr.

Professor Libby, internationally known for his research achievements, teaching, and writings in pulp and paper manufacturing, is resigning his position as head of the Department of Pulp and Paper Manufacturing of the College of Forestry, State University of New York, to accept the North Carolina State College assignment.

Professor Libby has been head of the Department of Pulp and Paper Manufacturing of the New York College of Forestry since 1920.

At North Carolina he will direct an enlarged program of teaching and research in pulp and paper technology designed to benefit the expansion of the pulp and paper industries of North Carolina and other states in the Southeast.

The Southern Regional Education Board has recognized North Carolina State College and the University of Florida as the two centers for pulp and paper technology work in the Southeast. N. C. State's interest is centered in undergraduate training while the University of Florida is designated for its work on the doctorate or post-graduate level.

Two years ago Professor Libby received world-wide acclaim for the completion of research work leading to the first successful commercial method of making mechanical pulp from hardwoods growing in the Northeastern States and Canada. The process is known technically as "Chemigroundwood."

Effect of Different Heat Treatments Upon the Viability and Vigor of Pine Pollen

Earl J. Hodgkins[1]
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IT IS A TRUISM that successful artificial pollination depends on purity of the pollen. In their significant discussion of methods of controlling pollination in pines, Cumming and Righter (*1*) recognize this fact. Before using a pollination bag, they subjected it to 80 to 82 degrees C. for 15 hours in order to kill any undesired pine pollen already within the bag. The present paper substantiates this heat application for killing contaminating pine pollen within pollinating equipment. Further, this paper reports the effects of other heat applications upon viability and vigor of pollen, and gives information concerning upper critical temperatures for pine pollen.

The heat-susceptibility of such materials as rubber and canvas used in pollinating equipment has an important bearing on the problem of applying heat to kill contaminating pollen. While the heat applied must be sufficient to kill the pollen, it must not damage these materials.

Procedure

The tests recorded herein were made at the Institute of Forest Genetics, Placerville, Calif.

Pollen from 15 trees was collected and stored according to the methods outlined by Cumming and Righter (*1*). These 15 trees represent nine species and one hybrid of the genus *Pinus* (See Table 1).

Eighty pollen samples were used in the experiment. Fifty-one of these were subjected to various heat applications in a hot air-circulating oven while 29 were used as checks. The heat applications used were as follows: 67 to 69 degrees C. for 12 hours, 21 hours, and 24 hours; 74 to 77 degrees C. for 24 hours; 77 to 80 degrees C. for 12 hours, 15 hours, and 24 hours; 80 to 82 degrees C. for 15 hours and 18 hours. Check-treating consisted merely of allowing a pollen sample to stand at room temperature while a duplicate sample was undergoing heat treatment.

Each sample, consisting of .1 to .2 cubic centimeters of pollen, was extracted from its cotton-stoppered storage vial by means of a hypodermic syringe. It was then ejected into a clean and cotton-stoppered testing vial and placed in the oven to be heated or allowed to stand at room temperature as a check.

After treatment, each sample was tested for viability and vigor according to the method described by Righter (*2*) and by Cumming and Righter (*1*). Briefly, this method consists of mixing distilled water with the pollen, transferring drops of the mixture by means of a pipette to small holes punched in a paraffin layer in a Petri dish, sealing the Petri dish with vaseline, inverting it, and placing it in an electric oven at 26 degrees C. It was usually possible to test six samples in one Petri dish, as illustrated in Figure 1. This not only permitted economy of effort, but also insured identical germinating conditions for both treated and check samples since both could be included in one Petri dish.

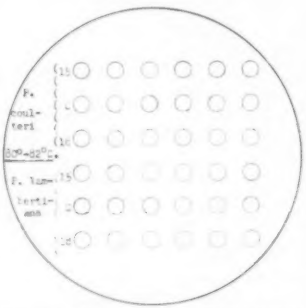

FIG. 1.—Diagram showing arrangement of Coulter and sugar pine heat treated and check pollens in a Petri dish for germination tests. The labels "15" and "18" indicate duration of heat treatments (80°-82°C.) in hours; "C" indicates check pollen. After the dish remained for 170 hours at 26°C. in the germination oven, germination percents from top to bottom were 0, 69, 0, 0, 30, and 0; vigor was 0, 2.8, 0, 0, 3.0, and 0.

Each Petri dish was left in the germination oven until all viable pollen within the dish had germinated. Complete germination occurred in each dish, depending on the species included, after from 30 to 80 hours. In determining the germination percentage[2] for each pollen sample between 135 and 1,000 microspores or pollen grains were counted. For all but six of the 80 samples, more than 250 microspores were counted. That these sample counts were adequate is indicated by the consistency of germination percentages obtained for different samples of check pollen from any one tree.

"Vigor" was obtained for each pollen sample by determining the average length of the pollen tubes as a multiple of the average width of the microspores. "Vigor relative to check pollen" (Table 1, Col. 7) was obtained by dividing each heat-treated pollen "vigor" by its corresponding check-pollen "vigor." These ratios reveal loss in vigor due to treatment and at the same time furnish a basis for comparing the various heat treatments.

Data and Discussion

Table 1 gives the treatment and the consequent germination and vigor for each pollen sample. Table 2 summarizes the germination data in Table 1 in terms of heat application, disregarding the individual samples and species involved. The percent survival of viable pollen (Col. 5, Table 2) was computed for each heat application by dividing the average of germination percentages of the heated samples by the corresponding average of the appropriate check samples and multiplying by 100. Percent mortality (Col. 6, Table 2) was computed by subtracting percent viability from 100.

[1]The author gratefully acknowledges the help of F. I. Righter, geneticist, U. S. Forest Service, in giving over-all direction to this work.

[2]Germination percentage was obtained for each sample by the formula:

$$\frac{\text{number of microspores with pollen tubes}}{\text{total number of microspores counted}} \times 100$$

TABLE 1.—LOSS IN VIABILITY AND VIGOR OF *PINUS* POLLEN FROM VARIOUS HEAT APPLICATIONS

Pollen sample No.	Species and tree	Heat application Temperature	Heat application Duration	Germination	Germination of check pollen	Ratio of heated pollen vigor[1] to check pollen vigor
		Degrees C.	*Hours*	*Percent*	*Percent*	
1	aristata No. 1	77-80	12	17	50	.5
2	aristata No. 1	77-80	15	4.5	50	.4
3	aristata No. 1	80-82	15	0	47	–
4	aristata No. 1	80-82	18	0	47	–
5	coulteri No. 1	67-69	21	65	75	.6
6	coulteri No. 1	67-69	24	65	75	1.4
7	coulteri No. 1	77-80	12	2	70	.3
8	coulteri No. 1	77-80	24	0	70	–
9	coulteri No. 1	77-80	12	34	68	1.0
10	coulteri No. 1	77-80	15	10	68	1.0
11	coulteri No. 1	80-82	15	0	69	–
12	coulteri No. 1	80-82	18	0	69	–
13	excelsa No. 1	67-69	21	30	37	.8
14	excelsa No. 1	67-69	24	21	37	.6
15	excelsa No. 1	77-80	12	2	23	–
16	excelsa No. 1	74-77	24	0	23	–
17	jeffreyi coulteri	74-77	24	0	48	–
18	jeffreyi No. 1	77-80	12	0	55	–
19	jeffreyi No. 1	77-80	24	0	55	–
20	lambertiana No. 1	77-80	12	15	30	.7
21	lambertiana No. 1	77-80	15	7	30	.5
22	lambertiana No. 1	80-82	15	0	30	–
23	lambertiana No. 1	80-82	18	0	30	–
24	ponderosa No. 1	67-69	21	30	40	.7
25	ponderosa No. 1	67-69	24	30	40	.7
26	ponderosa No. 1	74-77	24	.5	40	.3
27	ponderosa No. 1	77-80	12	0	45	–
28	ponderosa No. 1	77-80	24	0	45	–
29	ponderosa No. 2	74-77	24	1	44	.6
30	ponderosa No. 3	74-77	24	0	45	–
31	ponderosa No. 3	77-80	12	4	39	.5
32	ponderosa No. 3	77-80	15	.5	39	.6
33	ponderosa No. 4	74-77	24	0	3	–
34	resinosa No. 1	67-69	12	60	63	.9
35	resinosa No. 2	67-69	21	57	57	.9
36	resinosa No. 2	67-69	24	40	57	.8
37	sylvestris No. 1	67-69	21	68	68	1.0
38	sylvestris No. 1	67-69	24	70	68	1.0
39	sylvestris No. 1	77-80	12	0	75	–
40	sylvestris No. 1	77-80	24	0	75	–
41	taeda No. 1	67-69	12	29	31	1.2
42	taeda No. 1	67-69	21	28	28	1.0
43	taeda No. 1	67-69	24	28	28	1.0
44	taeda No. 1	77-80	12	0	24	–
45	taeda No. 1	77-80	24	0	24	–
46	taeda No. 2	77-80	12	1.5	53	.2
47	taeda No. 2	77-80	24	0	53	–
48	taeda No. 2	77-80	12	8	56	.7
49	taeda No. 2	77-80	15	4	56	.4
50	taeda No. 2	80-82	15	0	55	–
51	taeda No. 2	80-82	18	0	55	–

[1]Pollen vigor: average length of the pollen tubes as a multiple of the average width of the microspores.

The application of 67 to 69 degrees C. is obviously inadequate for decontamination. Although the average mortality of viable pollen increased with length of treatment at this temperature range (see Table 2), the 82 percent survival after 24 hours indicates that the time required to kill the pollen completely would be too long for practical use.

Unfortunately, 74 to 77 degrees C. was applied for only the one time interval of 24 hours. As the average mortality of viable pollen was 99.3 percent, and since mortality was complete in four of the six samples involved, it seems likely that 26 to 28 hours at this temperature range would kill all pollen.

The application of 77 to 80 degrees C. caused an average mortality of 86 percent after 12 hours, 90 percent after 15 hours, and 100 percent after 24 hours.

The application of 80 to 82 degrees C. caused 100 percent mortality after both 15 and 18 hours. Additional tests for shorter time intervals were not made because the results of applying 77 to 80 degrees C. for 12, 15, and 24 hours seemed to indicate that 80 to 82 degrees C. would completely kill pollen after approximately 15 hours. Apparently, 15 hours at 80 to 82 degrees C. not only completely kills pine pollen, but also provides an hour or two margin of safety. Unlike lower temperatures, 80 to 82 degrees C. unfortunately caused some damage to pollination equipment. The damage, however, consisted only of a slight darkening in the amber-colored rubber of the vial caps. Strength and elasticity of the rubber did not seem to be impaired. This temperature caused no damage to Arrowhead Fabric Special cement, used by the Institute of Forest Genetics on the seams of pollination bags and pollen extractor bags, or to the Lumarith windows of these bags, or to the Lumarith cement used to seal the windows in place. Higher temperatures cause serious loss in strength and elasticity of rubber and in adhesiveness of these cements.[3] Because 80 to 82 degrees C. is low enough to cause only the slightest damage to pollination equipment, this temperature is satisfactory for practical use. The time of 15 hours is also satisfactory, for it permits one to place equipment in an automatically controlled oven at 5 p.m. and to remove it the next morning ready for use at 8 a.m.

Vigor of surviving pollen, as shown by the data in Table 1, Col. 7, was not on the whole affected by subjection to temperatures of 67 to 69 degrees C. It was, however, significantly lowered by all the higher temperatures used.

Upper critical temperatures are shown by this study to be much higher for pine pollen than for vegetative tissues of trees, and possibly to be about the same for pine

[3]Previous experience at the Institute of Forest Genetics showed that temperatures of 84 degrees and higher caused the rubber caps to lose elasticity, and resulted in a clouding of the "Lumarith" windows upon contact with moisture.

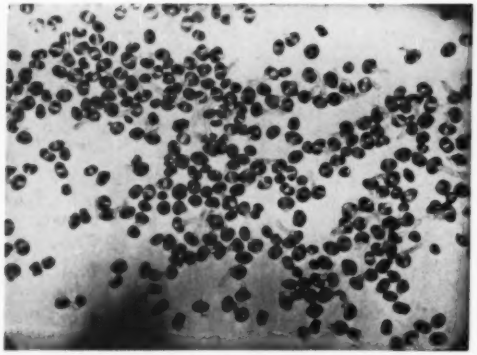

FIG. 2.—*Pinus aristata* Engelm. check pollen (×60). Photograph taken 48 hours after germination test was started. After 142 hours, germination was 47 percent and average vigor was 2.9. (Average length of the pollen tubes was equal to 2.9 times the average width of the pollen grains.) (*U. S. Forest Service photo*).

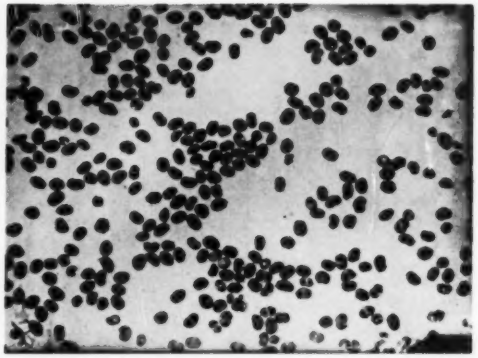

FIG. 3.—*Pinus aristata* Engelm. pollen subjected to 80 to 82 degrees C. for 18 hours. Photograph taken 48 hours after germination test was started. Germination after 142 hours was still zero. Results were the same for a treatment of 80 to 82 degrees C. for 15 hours, but 77 to 79 degrees C. for 15 hours left 4.5 percent of the pollen viable, while 77 to 79 degrees C. for 12 hours left 17 percent viable.

TABLE 2.—AVERAGE GERMINATION, SURVIVAL, AND MORTALITY OF PINE POLLEN AFTER VARIOUS HEAT APPLICATIONS[1]

Heat application Temperature	Heat application Duration	Average germination	Average germination of check pollen	Survival of viable pollen[2]	Mortality of viable pollen[3]	Samples used
Degrees C.	*Hours*	*Percent*	*Percent*	*Percent*	*Percent*	*Number*
67-69	12	44	47	94	6	2
	21	46	51	90	10	6
	24	42	51	82	18	6
74-77	24	.25	34	.7	99.3	6
77-80	12	7	49	14	86	12
	15	5	49	10	90	5
	24	0	54	0	100	6
80-82	15	0	50	0	100	4
	18	0	50	0	100	4
Total samples						51

[1]This table summarizes the data in Table 1 according to the various heat applications. Individual samples and species are ignored.

[2]$\frac{\text{Germination percent of heated pollen}}{\text{Germination percent of check pollen}} \times 100$

[3]100 survival percent of viable pollen.

pollen as for most tree seed. Toumey and Korstian (3) state, "... the actual killing point, or thermal death point, for leaves of many plants occurs at or near 122° F. (50° C.)," and "Surface soil temperature above 130° F. (54.4° C.) often proves fatal to young seedlings." They also state, "Seeds, when thoroughly dried, often safely resist a temperature of 158° F. (70° C.) without having their viability impaired, and for a short time a temperature as high as 212° F. (100° C.)." Compare these temperatures with the 67 to 69 degrees C. which most pine microspores can withstand for 24 hours, and with 77 to 80 degrees C. which some microspores (10 percent) can withstand for 15 hours.

Summary and Conclusions

Fifty-one pine pollen samples, representing nine species and one hybrid, were subjected to various heat applications. The objective was to find a convenient application which would completely kill contaminating pollen in pollinating equipment without damaging the equipment.

Temperatures of 74 to 77 degrees C. were completely lethal soon after 24 hours, 77 to 80 degrees C. at approximately 20 hours, and 80 to 82 degrees C. at 15 hours.

Exposure to 80-82 degrees C. for 15 hours is recommended for general use because it does little or no damage to pollination equipment, and because the time interval is convenient.

Vigor of surviving pollen was not decreased by subjection to 67 to 69 degrees C., but was significantly decreased by subjection to 74 to 77 degrees C., 77 to 80 degrees C., and 80 to 82 degrees C.

Pine pollen is more resistant to heat-killing than vegetative tissues of trees, and possibly is equal in resistance to most seeds of trees.

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Relative Blight Resistance of Some Chestnut Species and Hybrids

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In 1943, trees of three species of chestnut (*Castanea*) and various types of chestnut hybrids in the federal test plots near Glenn Dale, Md., were inoculated with the blight fungus *Endothia parasitica*. The hybrids were obtained from interspecific and intervarietal crosses made for various purposes. Determination of the relative blight resistance of the hybrids for comparison with the high resistance of the Chinese (*Castanea mollissima*) and Japanese (*C. crenata*) chestnuts, and with the high susceptibility of the American chestnut (*C. dentata*) was desired as a guide for use in further breeding work and for the selection of hybrids that would be sufficiently resistant for forest and wildlife plantings.

Materials and Methods

Approximately 1,400 trees, ranging in age from 5 to 13 years, were given more than 2,200 inoculations. Seedlings less than 5 years old were not used, because the writer has observed over many years that such seedlings, especially if derived from blight-resistant parent trees, are not readily infected by the fungus. Trees of the blight-resistant *mollissima* and *crenata* derived from open pollination were not available for inoculation, but progenies from controlled intercrosses made within these species were used.

The chestnut blight fungus was isolated in 1943 from a canker on *dentata*, which had recently died from the infection. From the original plate culture a single spore was obtained from which a number of subcultures were grown on cornmeal agar in Petri dishes. The inoculum was taken from these subcultures and for each inoculation consisted of a mass of spores, mycelia, and substrate.

Hunt (*3*) reported that the frequency of blight infections on American chestnut trees was greatest on the trunks, and that the frequency of cankers on the trunks decreased in the following order: east, west, north, and south sides. In 1940 Donald C. Stout and the writer inoculated blight-resistant chestnut trees at the Arlington Experimental Farm in Virginia, and obtained the same sequence for the frequency of infections on the trunks. In the study reported here, severe inoculations with the pathogen were desired; therefore, trees were inoculated on the east side of their trunks. To insure infection, each tree was usually inoculated twice, the inoculations being placed between ground level and four feet above on the trunk. If both inoculations on a trunk produced cankers, the dimensions of the larger canker were taken.

The bark at the point of inoculation was wiped with cotton moistened with alcohol. Uniform incisions were made through the bark and a short distance into the wood by means of a modified cork punch (*1*) ¼ inch in diameter. A piece of inoculum, slightly smaller than the bore of the punch hole, was picked up with an alcohol-sterilized dissecting needle and was placed in the wound. A square of surgical adhesive tape was placed over each hole. Punch holes for the controls were left empty but were closed with tape. Of 165 control punch holes, two developed cankers.

The inoculations were made within a period of 5 weeks, beginning July 8, 1943. Cankers were measured 2 months, 4 months, 10 months, 2 years, and 4 years after inoculations were made. Inoculations that did not produce infection after 10 months were considered failures. Records of trees killed by infection resulting from inoculation were also taken at yearly intervals. Instances occurred where cankers from natural infections joined with inoculation cankers, and sometimes sunscald and winter injuries affected the trunks. Trees affected by such factors were not included in the data presented in this study.

Usually the cankers on tree trunks are ellipsoidal in shape, and are longer in the direction of the long axis of the trunk. The area of a canker was obtained from the product of width times length, measuring to the nearest quarter of an inch. This product gives the area of a theoretical rectangle that is about 27 percent larger than an ellipse whose axes have the same dimensions; however, no correction was made to obtain the actual area of cankers. Since all canker areas were calculated by taking width times length, no significant error was introduced in the results.

The data on cankered areas 10 months after inoculation appeared to be more useful than those of any other period for showing the relative progress of infections. At this time some cankers on resistant trees were beginning to heal at the lateral margins, while some cankers on susceptible trees were about to girdle the trunks. Later, with these reactions progressing, the cankered areas would not be measured easily.

Evaluating Blight Resistance in Species and Hybrids

Two factors of infection were calculated to indicate relative susceptibility to the blight: percentage of infection and percentage of trees killed by infection resulting from inoculation. A third factor, average area of cankers 10 months after inoculation, was included to indicate the relative progress of the fungus through the bark. This factor, expressed in square inches, is an arbitrary one, but could be expressed fundamentally as a percentage of the trunk circumference covered by the canker. The various types of cankers produced by interaction of host and parasite could not easily be evaluated numerically, and therefore were not considered in this study.

The results from inoculating trees of three species and of various groups of hybrids are shown in Table 1. To conserve space, the

several races of *mollissima* used in the breeding project are not disguished in the table; however, the wild form of *crenata* is distinguished from the horticultural form. Also, several hundred hybrids derived from crossing Van Fleet hybrids, and Boone and Fuller chestnuts are not included because the parental trees no longer are of breeding or economic significance. Hybrid combinations consisting of but one representative are omitted.

Evaluation of Hybrids on Basis of Blight Resistance and Other Characteristics

Crosses between the tree chestnuts (*mollissima*, two forms of *crenata*, and *dentata*) were made for the investigation of growth rate and form of the first-generation trees. Combinations of the two forms of *crenata* and *dentata* yielded trees least satisfactory on the bases of growth rate, form, and blight resistance. Some combinations of the wild form of *crenata* and *mollissima* produced promising trees, the advantage of which in forest plantings is that any seedling reproduction from them would be blight resistant. The most promising hybrids for timber trees were derived from the combination of *dentata* and a particular selection of *mollissima*. These hybrids (Fig. 1) are superior in growth rate, form, and blight resistance to hybrids derived from other combinations of *dentata* and *mollissima*. They carry an average ranking of 18 compared with 25 for the entire group of *mollissima* x *dentata* hybrids. On soil of poor quality at Glenn Dale they have increased in d.b.h. up to $\frac{1}{2}$ inch per year, and in height an average of 2.8 feet per year for the first 12 to 15 years. They would certainly surpass their present performance in all respects when planted on selected sites. Seedling reproduction from forest plantings of this hybrid would pertain to the second generation, and at least one-half of the reproduction would range in resistance from that of the F_1 trees to that of the *mollissima* parent. No efficient method has yet been devised for the mass production of this hybrid, whether by sexual or by vegetative propagation. The nuts of this cross are of good quality and are much larger than the nuts of the American chestnut.

First-generation hybrids of *mollissima* x *dentata* were backcrossed to various *mollissima* selections to increase the resistance of progeny to the blight. The backcross-generation trees are practically as blight resistant as the *mollissima* parents, their rankings in this respect being 12 and 10 respectively. They also approach the *mollissima* parents in growth rate and form, and so are considered less satisfactory than the superior F_1 trees for use in forest plantings.

Crosses were made between the tree chestnuts and native chinkapins (*alabamensis*, *floridana*, *margaretta*, *ozarkensis*, and *pumila*) for the development of early bearing and productive trees that would supply food for wildlife. The Seguin chestnut (*C. seguinii*), a small everbearing tree from China, was also used in combination with the tree chestnuts and native chinkapins. The everbearing habit appears to be dominant or nearly so, and hybrids involving this species would be especially desirable except for their susceptibility to winter injury. This defect augments the development of blight.

Discussion

Graves (*2*) recently published the results of his investigations on the relative resistance of species and hybrids of *Castanea* to the blight. His evaluations of resist-

TABLE 1.—RESULTS OF INOCULATING SPECIES AND HYBRIDS OF CHESTNUT

Species or hybrids	No. of trees inoculated	Percentage infected[1]	Average area of cankers[1] (*Square inches*)	Percentage killed (1943-47)	Average rank[2]
Species of *Castanea*					
mollissima x (*mollissima* x *mollissima*)	2	50	9	0	7
mollissima x *mollissima*	71	69	5	4	10
crenata x *crenata*	30	73	8	0	11
dentata	22	91	19	55	31
Hybrids					
crenata x (*mollissima* x *dentata*)	8	25	6	0	3
mollissima x (*mollissima* x *crenata*)	20	40	4	0	3
mollissima x *alabamensis*	2	50	1	0	3
mollissima x (*floridana* x *dentata*)	6	50	3	0	4
mollissima x *ozarkensis*	7	57	6	0	7
mollissima x (*mollissima* x *dentata*)	140	64	6	12	12
crenata-w[3] x *ozarkensis*	8	75	3	38	15
(*crenata-w* x *mollissima*) x (*mollissima* x *dentata*)	4	75	6	25	16
(*mollissima* x *pumila*)F_2[4]	4	50	6	50	16
alabamensis x *seguinii*	4	50	11	25	17
mollissima x *crenata*	61	90	11	2	18
crenata-w x (*crenata-w* x *dentata*)	3	100	19	0	18
crenata-w x *dentata*	7	100	18	0	18
(*mollissima* x *dentata*)F_2	8	100	9	0	18
(*mollissima* x *crenata*)F_2	77	87	11	13	20
crenata x *alabamensis*	15	67	11	40	20
mollissima x *pumila*	25	96	13	8	22
mollissima x *crenata-w*	39	97	17	5	23
crenata x *dentata*	17	91	14	18	23
crenata x (*pumila* x *crenata*)	8	87	10	50	23
mollissima x *dentata*	89	97	18	8	25
dentata x *seguinii*	8	87	15	50	27
crenata-w x *margaretta*	8	88	14	75	28
mollissima x (*mollissima* x *pumila*)	5	100	12	40	30
floridana x *crenata-w*	3	100	15	33	30
floridana x *dentata*	2	100	24	50	36

[1]Ten months after inoculations.

[2]This is an average of the three ranks obtained for each group in the three preceding columns.

[3]The wild form of *crenata* as distinguished from the horticultural varieties.

[4]The F_2 or second generation was obtained by intercrossing the F_1 hybrids.

ance were based on inoculation results and on personal observations. He set up five classes of disease intensity ranging from very resistant to very susceptible. For each class he describes the typical reaction of the host to the parasite, including presence or absence of the fungus in the bark, rapidity of growth of the fungus, and the degree of healing or nonhealing of cankers. With this method of evaluating resistance, some types of hybrids fell into two or three classes each, indicating that the resistance of a particular type varied over a wide range between the limits of very resistant and very susceptible.

The species and hybrids used in this investigation varied in age and in spacing in the test plots, and they grew on soil of varying quality. Under such conditions it is highly desirable to minimize variation in methods and techniques. Efforts to reduce unwanted variation were made by inoculating the same side of the trunks, inoculating within a given area on the trunks, inoculating in a season (summer) when optimum activity of the pathogen could be expected, with a standard size wound and a standard amount and kind of inoculum. The objective was to obtain inoculations whereby non-infections would indicate resistance on the part of the host rather than faulty technique, and whereby the course of infections would reflect a maximum response on the part of either the pathogen or the host.

Even with such care to eliminate unwanted variation, some groups of hybrids do not fall into proper sequence consistent with their observed resistance. Variations in soil nutrients, soil moisture, light, and susceptibility to sunscald and other forms of winter injury no doubt affect the progress of blight infections and account for some of the inconsistent rankings in Table1.

Backerosses of *mollissima* x *dentata* on *mollissima* have been observed for 15 years, and their resistance to blight appeared to be unusually high. This observation, together with the rank of the inoculated trees, indicates that resistance in the backeross generation is higher than would be expected if

FIG. 1.—A group of first-generation hybrids, 15 years old, from crossing *C. mollissima* and *C. dentata*.

only one pair of genes controlled resistance to blight. If two pairs of genes control resistance, this backeross generation should present 3 resistant individuals to 1 susceptible. A frequency distribution of canker areas (Table 2) shows a maximum drop from 52 trees with canker areas of 0.5 to 6.0 square inches to 19 trees with canker areas of 6.1 to 11.0 square inches. The 52 trees in the smallest canker area class with the 51 trees that were not cankered total 103 in the resistant class, leaving 37 in the susceptible class. These figures approximate a 3 to 1 ratio, the theoretical ratio being 105 to 35. The method of inheritance of blight resistance needs further investigation, preferably by analysis of a large second-generation population. If the two gene-pair hypothesis is substantiated, it will indicate that seedling reproduction from these hybrids, whether of the first or backeross generation, will have a higher average resistance than if but one pair of genes were involved.

TABLE 2.—FREQUENCY DISTRIBUTION OF CANKER AREAS OF *Mollissima* X (*Mollissima* X *Dentata*) HYBRIDS

Canker area classes[1]	Frequency
Not cankered	51
0.5 to 6.0 (sq. ins.)	52
6.1 to 11.0	19
11.1 to 16.0	11
Over 16.1	7
Total	140

[1]Data taken 10 months after inoculation.

Summary

Approximately 1,400 trees of three chestnut (*Castanea*) species and numerous types of hybrids ranging in age from 5 to 13 years were given more than 2,200 inoculations with the chestnut blight fungus, *Endothia parasitica*, in 1943 at the federal test plots near Glenn Dale, Md. Data were taken 2 months, 4 months, 10 months, 2 years, and 4 years after inoculation to obtain information on the percentage of trees infected, average area of cankers, and percentage of trees killed.

First-generation trees obtained by crossing a selection of *mollissima* with *dentata* show promise for use as timber trees. Their resistance to blight appears to be sufficient to justify using them for extensive experimental forest planting whenever a practicable method is developed to increase the stock on a large scale. The backeross generation obtained by crossing the F_1 with *mollissima* shows a resistance to blight almost equal to that of the *mollissima* parent. However, the growth rate and form of the backeross-generation trees also resemble these characteristics in *mollissima* and hence they are considered less satisfactory than the superior F_1 trees for use in forest plantings.

From an analysis of the frequency distribution of canker areas in this backeross generation, the hypothesis is advanced that two pairs of genes control resistance to blight.

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Timber and Forage Production in a Pine-Hardwood Stand in Texas[1]

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THE COASTAL PLAINS FOREST area includes some 100 million acres which contribute substantially to the support of approximately 12 million head of livestock, 7.5 million of which are cattle (*6*). In East Texas, forest stands comprised of loblolly pine[2] and its associates dominate 5,000,000 acres, and according to the 1945 Texas census contribute to the support of 700,000 cattle.

Considerable forest range research has been accomplished in the longleaf pine types of the Southeast during recent years, but little has been initiated in the loblolly pine types. The longleaf pine types, because of the open nature of the stands created in part by the intermittent use of fire, produce a far greater volume of forage. Nevertheless, the forage of the loblolly pine types, throughout their extent, is relied upon by cattlemen for a portion of the livestock sustenance. With the rapid increase of the livestock populations throughout the Southeastern states, additional information regarding the management of native forage production should be forthcoming in order to integrate livestock management with timber production. In order to contribute to the solution of this problem, a study was initiated in Montgomery County, Texas during the winter of 1947-48 to determine the volumes of forage and timber produced in unmanaged loblolly pine-hardwood stands.

Literature Review

It is generally accepted that timber production is a profitable enterprise throughout the southeastern pine forest region of the United States, but the production of livestock forage in conjunction with the production of timber has only recently received consideration. Investigations during the past decade have brought to light many of the problems confronting range specialists, timber owners, and livestock owners of the region.

A survey by Biswell and Foster (*2*) showed that the cattlemen in the Coastal Plain of North Carolina depend upon forest range for 29 percent of the year-long sustenance for beef cattle. Similar surveys in the Coastal Plain of Georgia by Biswell et al (*4*) and in Louisiana by Campbell and Rhodes (*7*) showed that forest range was relied upon for 65 and 69 percent, respectively, of the year-long sustenance for beef cattle. Cattlemen in the loblolly pine-hardwood type of Georgia relied upon native range for 41 percent of the year-long sustenance, while the corresponding figure for Louisiana was 54 percent. These surveys clearly indicate the need for improved grazing and livestock management practices in order to obtain the greatest benefit from the dual objective of forage and timber production.

The density of forest stands has a direct influence upon the factors which determine the quantity of forage produced beneath the canopy (*5*). The reduction of light intensity favors the shade-enduring shrubs and weeds which further reduce the quantity of light reaching the forest floor. Consequently, only a few short-lived shade-enduring grasses are able to persist under dense timber stands. Studies in Louisiana (*9*) indicated that the quantity of forage produced in the shortleaf - loblolly pine - hardwood type was less than that produced in any other forest type in the state. These studies revealed that 53 percent of the forage produced in the shortleaf-loblolly pine-hardwood type was composed of grass species, while the comparable figure for the longleaf pine type was 94 percent.

A study of forage production in slash pine plantations in southwest Louisiana (*9*) illustrated the effect of shade upon the quantity of forage produced. The edible air-dry forage produced per acre per year declined from 600 pounds on unplanted sites to 95 pounds in 15-year-old plantations.

Biswell and Hoover (*3*) found a wide variation in the degrees of utilization of Appalachian hardwoods by cattle under intensive stocking rates. Browsing of available forage ranged from 90 percent of ash to none of red maple.

The need for additional information regarding the management of loblolly pine-hardwood forests for the production of forage and timber is clearly indicated by the scarcity of fundamental research and consequently the scarcity of literature pertaining to the subject.

Description of Area Studied

This study was made in an unmanaged loblolly pine-hardwood stand near Dobbin, Montgomery County, Texas in low rolling hill country approximately 200 feet above sea level. The forest composition was comprised of loblolly pine, shortleaf pine, post oak, southern red oak, winged elm, red gum, black gum, hickories, ash, and numerous minor species. Herbaceous vegetation occurred principally in the openings, but several species of grasses and forbs were persistent under shade. Browse species occurred in considerable quantities under the shade as well as in the openings. The area was logged during 1936 in an operation which removed only pines 10 inches and over in diameter at 1 foot above the ground.

The mean annual precipitation for the vicinity is approximately 43 inches, although the precipitation for 1948 was almost 20 inches below the average and that for 1947, 9.5 inches below the average.

[1]This paper is a portion of a Masters thesis prepared under the supervision of Dr. Vernon A. Young of the Department of Range and Forestry, Agricultural and Mechanical College of Texas, College Station.

[2]Common names used according to Kelsey, H. P. and W. A. Dayton. Standardized Plant Names 1942; and Reeves, R. G. and D. C. Bain, Flora of South Central Texas. 1947.

The soils consisted of loamy fine sand and fine sand underlain with mottled sandy clay. In general, the profiles were typical of East Texas piney woods upland soils. The topsoil varied in depth from 10 to 27 inches.

The fire history of the area is not definitely known. However, the area has received complete protection during the past ten years (*1*).

Methods

Three types of plots were located in a typical loblolly pine-hardwood stand in Montgomery County. Six ¼-acre timber plots were established during the summer of 1947. The total basal areas of all tree species were determined as follows:

Plot Number	Basal Area
	Sq. ft.
1	126.7
2	58.1
3	116.6
4	93.2
5	104.6
6	73.6

Figure 1 illustrates the extremes of timber densities in the six plots. All plots were located on the same slope and approximately the same contour. The plots were protected from livestock throughout the study.

Tree data were segregated into two broad groups: pine and hardwood. Within the groups, trees were segregated into the following four diameter classes: 0.5 to 4.5 inches, 4.6 to 8.5 inches, 8.6 to 12.5 inches, and 12.6 inches and larger. These groupings were used throughout the study for developing density, stand, and volume tables.

Growth data were obtained by boring 20 percent of the trees in the two intermediate diameter groups and all trees in the largest diameter group. Merchantable heights were estimated and spot checked with a hypsometer.

For herbaceous forage studies nine ½-milacre plots (42.25 inches by 74.25 inches) were selected in each of the six ¼-acre timber plots. Three of these were established under pine shade, three under hardwood shade, and three in openings in the canopy. In each of these conditions, one plot was taken under the densest shade, one under the lightest shade, and one under medium shade.

Observations of herbaceous vegetation continued for 12 months, although clippings were available only from May 1 to October 29. Clippings were made at 4-week intervals at a height simulating proper use. Each species was permitted to produce seed on a majority of the individual plants before clipping, and 20 percent of the seedstalks were left. All clippings were allowed to air-dry for 4 weeks, after which they were oven-dried at 35 degrees C. for 24 hours. Weights were taken to the nearest 0.05 gram.

For determining the yearly production of browse forage the method employed was modified from the procedures used by Canfield (*8*) in the Southwest and Warner (*10*) in southeastern Texas. Current growth of browse plants was clipped to a height of 5 feet from ten ¼-milacre belt transects, 10.89 feet by 1 foot, spaced at regular intervals diagonally across each

FIG. 1.—Timber plots possessed a wide variation of stocking. Plot 1, *above*, supported the highest basal area density. Plot 2, *below*, supported the lowest basal area density.

timber plot. A collapsible frame was devised and used to measure the height and width of the transects. A single clipping was made during the fall after growth had ceased. Oven-dry weights were obtained of individual species on each plot.

Results

Production of Timber.—The volume of timber produced during 1948 was small, probably because of the low precipitation in 1947 and 1948. The average volume of growth per acre on trees 4.6 inches and larger was 41.2 cubic feet. The largest increment was made in Plots 4 and 5, although Plots 1 and 3 possessed greater basal areas. The fact that Plots 4 and 5 had a greater proportion of trees in the larger diameter classes than Plots 1 and 3 accounts for the greater volume of increment. The hardwoods were of poor form and vigor, consequently their volume of growth was small.

Production of Herbaceous Forage.—Herbaceous vegetation produced during 1948 was 50.8 pounds per acre. Of this 21.1 pounds was classed as desirable or less desirable forage for cattle; the remainder was undesirable. This rate of production compares favorably with studies made in Louisiana (9) in which 20-year-old unthinned slash pine plantations produced 35 pounds of edible air-dry forage per acre. Desirability classes were determined on the basis of observed preference by cattle and the ability of the species to withstand grazing and to endure moderate shade.

The highest yield of desirable forage was taken from timber Plot 3, which also supported the second highest density of timber. The yield of desirable grasses and forbs on this plot was 51.9 pounds per acre, with longleaf uniola the principal species. This grass is a rather tolerant species and may produce heavy stands under moderate to heavy shade. Timber Plot 2 with the lowest density of timber produced the highest yield of undesirable herbaceous vegetation which consisted principally of forbs.

There was no consistent relationship between the density of timber and the volume of herbaceous vegetation produced, although the plot supporting the highest density of timber yielded the smallest volume of herbaceous vegetation, while the plot supporting the lowest density of timber produced the largest amount (Fig. 2). The forage volumes produced on the plots with intermediate timber densities bore no relationship to the tree densities. Irregular occurrences of longleaf uniola and several species of *Eupatorium* contributed to the wide variations in yields.

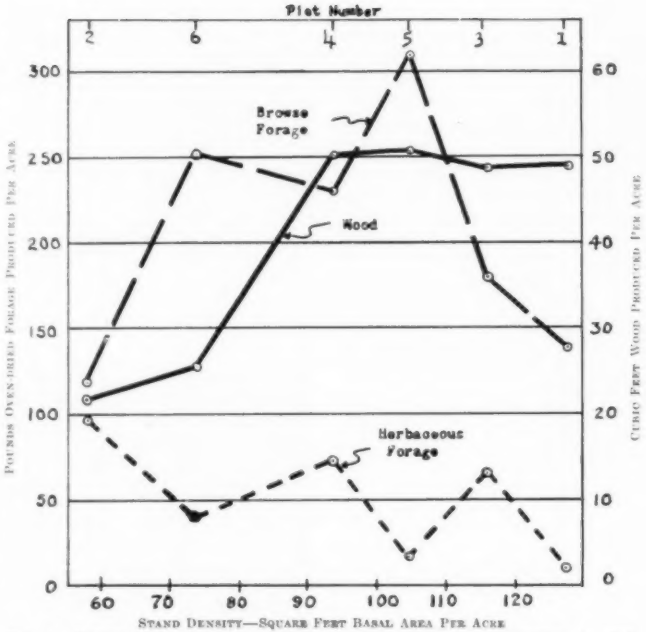

FIG. 2.—Forage and wood volume produced during the growing season of 1948. Scale on left refers only to browse and herbaceous forage production. Scale on right refers only to wood production.

The production of herbaceous vegetation, with one exception, was correlated with the kind of overstory. The production of desirable and less desirable grasses was lowest under pine shade, intermediate under hardwood shade, and highest on open sites. The same relationship was apparent for the undesirable forbs. Desirable forbs and undesirable grasses did not show this relationship to variation of kind of overstory.

The yield of undesirable herbaceous vegetation was highest in the open sites with 47.9 pounds per acre. Under pine and hardwood shade the yields of herbaceous vegetation were 16.2 and 24.8 pounds per acre, respectively. The yield of desirable forbs was negligible.

Production of Browse Forage.—The volume of browse forage production was considerably greater than that of herbaceous forage and amounted to 205.5 pounds per acre. This consisted of the following: shrubs, 74.6 percent; trees, 16.1 percent; and vines, 9.3 percent. American beautyberry, or French mulberry, produced 143.1 pounds per acre or approximately 70 percent of the current browse. Other important species were: southern red oak, winged elm, Alabama supplejack, parsley haw, and saw greenbrier. Other miscellaneous species produced less than 10 percent of the current browse. St. Johnswort and Carolina jessamine, known to be slightly poisonous, produced approximately 2 percent of the browse. The evergreen species southern waxmyrtle, yaupon, and the saw greenbrier produced

approximately 3 percent of all browse. With the exception of one timber plot the volume of browse forage decreased as the composition of hardwood timber species increased. The same relationship occurred between the production of American beautyberry and the composition of the hardwood timber species. In each instance, however, timber Plot 3 deviated from the trend. The highest yields of browse were produced in timber plots with basal area densities of 73 and 104 square feet per acre.

Figure 2 shows, in graphic form, the relative production of wood as compared with the production of browse and herbaceous forage. It should be noted that, while there is no apparent correlation between wood and forage production, there is a rather consistent correlation between the production of browse and herbaceous forage. An increase in browse forage production is accompanied by a decrease in herbaceous forage production in stands with less than 115 square feet of basal area. When the stand density exceeds 115 square feet both types of forage production decline.

Recommendations.—On the basis of this study the following management practices appear to be worthy of consideration:

1. Make tree thinnings in order to maintain the basal area of the stand between 90 and 115 square feet.

2. Gradually eliminate low-grade hardwood trees.

3. Prevent the growth of hardwood browse species as much as is economically feasible in order to encourage the growth of herbaceous forage.

4. Encourage the growth of such shade-enduring species as longleaf uniola and blackseed needlegrass by removing livestock sufficiently early for the grasses to mature seed.

5. Disregard the forage produced in the type studied during the season following a drought year, except for a few weeks in early spring. Early maturing grasses such as longleaf uniola and blackseed needlegrass produce limited forage in winter and early spring when moisture is available.

Summary

Unmanaged pine-hardwood timber stands on loamy soils in Montgomery County, Texas with 90 to 115 square feet of basal area appear to produce the best combination of wood volume, forage, and browse. Under this condition wood production amounted to 41 cubic feet, herbaceous forage 51 pounds, and browse 205 pounds per acre. Precipitation was deficient during the seasons of 1947 and 1948 when the study was made.

Timber density had little effect on the quantity of desirable forage produced, though undesirable forbs generally decreased with an increase in the timber density.

The effect of a specific type of shade showed the most consistent influence on forage production, although the data were insufficient for definite conclusions. Light passing through the naked crowns of deciduous hardwoods was sufficient to stimulate the growth of early-maturing grasses. Under such conditions these grasses were able to utilize the winter moisture and produce considerable growth, notwithstanding the annual precipitation was below normal.

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Attention: Members, Division of Silviculture

At Biloxi the members requested that duplication and distribution of papers presented in the Division meeting be investigated. R. H. Westveld, our Secretary, has followed up on the suggestion. He has learned that two of the papers from the morning session have been submitted directly by their authors (Chapman and Pomeroy) to the JOURNAL OF FORESTRY. Dean Korstian has assembled all the papers from the "Southern pine silviculture symposium" and submitted them as a group to the JOURNAL. Apparently none of the authors of the remaining papers wishes to have them published or distributed.

RUSSELL K. LEBARRON, *Chairman,*
Division of Silviculture.

Underground Damage from Logging in the Western White Pine Type

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In connection with a study to determine the cause of pole blight, a serious disease of pole size western white pine (*Pinus monticola* Dougl.) 14 trees of this species on a wide range of sites had their entire root systems exposed by hydraulic washing. Recently the writer watched this operation on a 90-year old white pine growing in a dense pole stand. As the litter and soil were washed away, there was revealed the extremely shallow position in which the roots lay. Most of the strong laterals were imbedded in the mineral soil just below the duff layer—about 4 inches under the surface. Many of these rope-like laterals, 1 to $1\frac{1}{2}$ inches in diameter near the tree bore their mats of feeding roots 50 feet away.

The duff layer (A_0 horizon) in northern Idaho white pine forests is thin. From 150 samples taken in the summer 1950, it was found that the organic layer under 60- to 90-year old white pine stands averages about 2 inches. The deepest accumulation found was only 4 inches and that in a climax forest. Consequently the horizon of highly concentrated plant nutrients and soil organisms, will be found only a few inches below the surface.

Noting the shallow position of so many roots raised a serious question. What damage might be occurring to the roots of residual trees under current methods of mechanized logging where heavy, powerful machines push and tear their way through the woods?

The writer, being primarily concerned with a research project on logging slash disposal, first examined areas where bulldozers with special blades had been used to pile slash. Unlike hand piling, the dozer gathers heavy debris—sweepers, long butts, and broken chunks—as well as the limby slash, leaving the ground fairly clear of fuels. Heavy material pushed ahead of the dozer blade gouges and churns duff and mineral soil, providing excellent seed bed preparation. However, on this distributed ground

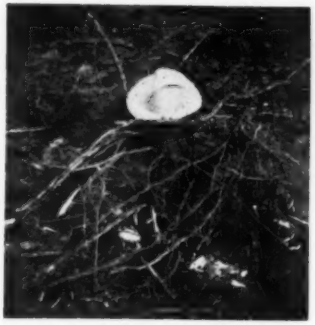

Fig. 1.—Roots of felled and residual trees left exposed after skidding and piling slash with dozer.

Fig. 2.—Severed roots draped over bank of logging road.

was found a maze of exposed and mangled roots, as shown in Figure 1.

Tractor skidding causes similar root damage. Under limited power in horse skidding days, logs were neatly trimmed to prevent hangups and to ease the pull. Now behind almost unlimited power, logs break through any resistance gouging and scouring a trail through the woods. Untrimmed broken branch stubs particularly in tree-length logging, rip through the soil 6 to 8 inches deep, pulling to the surface broken and mangled roots. Just maneuvering the tractor scoops up ridges, leaving many exposed, bruised roots. Root injury is less likely to occur in winter logging where snow and ice afford some protection to the ground. Other things being equal, the degree of logging damage done in tractor skidding varies with operators, and while they are generally aware of such skidding damage as barking, cable burns, and destruction of reproduction, few realize the damage occurring underground.

Skid trails, jammer spurs, truck hauls and, in fact, any kind of dozed out woods' road shows another type of root damage. Usually the roads are cut across slopes leaving high banks on the upper sides. Practically all tree roots crossing the road location are severed. A typical example of such severed roots draped over the cut is shown in Figure 2. Note that these roots come largely from a zone between the dark organic layer and the lighter mineral soil, about 4 inches below the surface.

The extent of this damage is widespread. On a typical jammer operation in northern Idaho (Fig. 3), dozed out spurs and truck hauls cross a square mile at least 10 times, or a mile to every 64 acres. The average width of tread and back slope is 26 feet. This amounts to 5 percent of the forest area, and is double that amount when width of right-of-way clearing is included. In tractor skidding, the linear measure of dozed skid trails is considerably greater.

Just what effect this root damage will have on the residual trees is unknown but the possibilities are grave enough to warrant intensive study such as has been undertaken in the white pine type on logging damage done above ground. Forest pathologists at the University of Idaho point out that hardly anything worse could be done to the residual trees to invite infection from such root diseases as shoestring root rot (*Armillaria mellea*), particularly in mangled roots resulting from skidding where the wounded parts are in contact with damp organic material teeming with disease organisms. Infection

is less likely in the severed roots draped over banks because they quickly dry out. Dozed out roads and skidding circumscribe many of the trees left in the residual stand, reducing much of the root systems and feeding areas supporting those trees. Until the severed roots have been replaced by new root development and extended to new ground, the trees are in a weakened condition, subject to windthrow, disease and insect attack, and in a state of arrested growth. The beneficial effect to be derived from stand release, may be offset by shock resulting from logging damage.

In general, western white pine silvicultural practices are pointed toward a final clearcutting. While it may be advisable to clearcut overmature and unthrifty mature stands in one operation, good management of young and thrifty mature white pine stands prescribes two or more cuts with an interval of twenty to thirty years between harvests. The partial cutting plan has as its silvicultural aims, to:

a. Capture potential mortality by getting over the area more quickly.

b. Improve growth and composition of the reserve trees to get full productvity of the site.

c. Maintain vigor of the residual stand to ward off insect attacks.

d. Reserve vigorous trees to assure adequate seed source.

e. Alternately open and close canopy density to devitalize duff-stored ribes seed in blister rust control, and to regenerate white pine.

Attainment of these goals depends upon unimpaired vigor in the residual stand. Unfortunately many of the partially cut stands begin to look sick about five years after logging. Many trees are windthrown or die from other causes. Normal growth is arrested in the weakened trees, and, whether on the average, there is a net gain in increment is questionable. These effects of logging shock have been attributed to the rapid opening of the stand by too heavy cutting and by mechanical injury above ground from logging operations. Root damage adds another hazard in carrying the reserve trees through to a profitable cut. The full significance of this type of damage may not be apparent for some time. Aside from outright tree losses and retarded growth, the quality of the timber may be lowered through cull and defect brought about by root infection. This underground damage may definitely tip the balance to nullify the silvicultural aims of partial cutting. In that case it would seem better to clearcut in one operation and start a new forest.

Slash treatment is appreciably affected by changes in cutting practices. In partial cutting, moderate slash can be handled safely by lopping and scattering the debris under the protective shade of the residual stand, and in the final cut, under the protective covering of advance reproduction. Heavy concentrations of logging slash are commonly reduced by burning and this is difficult to do without scorching boles and tops of residual trees and burning through the duff to cause root damage. Now that foresters are aware of root damage caused by the dozer piling, it is believed that this can be substantially reduced through changes in machine design and greater care by the operator.

However, this damage dwindles to minor significance when compared with similar classes of injuries caused by current mechanized logging methods. It is not expected that mechanized logging will be discarded, but awareness of the damage caused by powerful machines in the woods should exert some influence toward more careful operation of these machines. There is urgent need for thorough investigations and evaluation of underground damage from logging, and if and where the facts indicate serious damage, aid of loggers and logging equipment manufacturers should be sought to improve methods and machine design. The alternative would be the wasteful method of clearcutting in one operation.

Summary

"Logging shock" results in considerable loss of trees and arrested growth in residual stands of west-

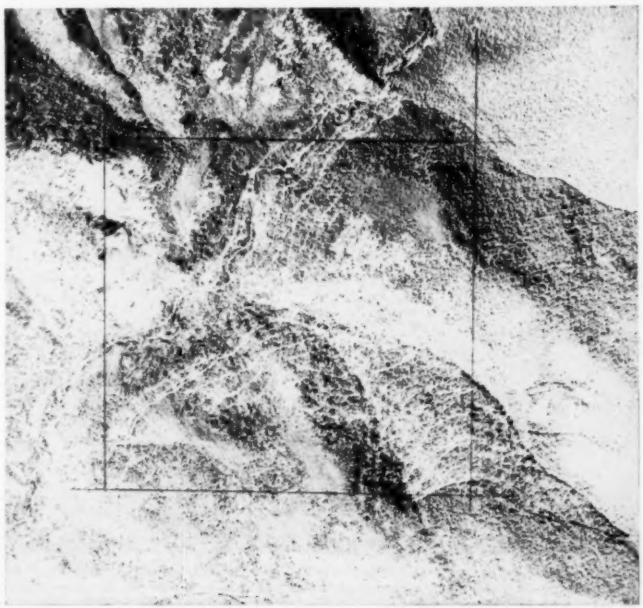

FIG. 3.—Aerial view of jammer spurs and logging roads.

ern white pine type. In the past, emphasis has been placed almost entirely upon logging damage above ground. Modern methods of logging are causing much damage underground—to roots of the residual trees. This type of damage may be very severe and require changes in cutting practices for the western white pine type. The problem seems serious enough to warrant intensive investigation.

Grass Production Doubled by Control of Scrub Oak

John T. Cassady
Southern Forest Experiment Station, New Orleans, La.

In this pine plantation in central Louisiana, the yield of bluestem forage grasses more than doubled within three seasons after scrub hardwoods were controlled. Under well-managed grazing, the increase in forage can repay most of the cost of hardwood control before the pines reach merchantable size.

A WIDESPREAD CAMPAIGN is being waged by forest landowners in the South to control unmerchantable hardwood trees that overtop and suppress young pines. The release of pines for rapid growth also permits increased growth of grasses and forbs for 10 to 15 years, or until the new tree canopy again reduces the undergrowth.

FIG. 1.—After being released (March 1948) from an overtopping heavy stand of scrub oaks, both grass and pine trees grew as if fertilized. Grass production doubled in three seasons following oak control. (Photo: August 1951, by Louisiana Forestry Commission.)

Since grass is utilized by livestock on many forest ranges, an increase in forage is of interest to range livestock producers. This article tells of increased forage brought about by oak control on a longleaf pine forest in central Louisiana.

Study Area and Treatments

The study area supported a mixed stand of about 330 blackjack and post oaks (*Quercus marilandica* and *Q. stellata*) per acre. The trees averaged 4.5 inches in d.b.h. and 37 square feet of basal area per acre—a moderately heavy stand of oaks on an upland site. The undergrowth consisted of a few scattered shrubs, and 704 pounds of grasses and 144 pounds of forbs per acre, air-dry weight. This is about one-third the amount of herbage normally produced on similar but open sites that have few or no trees. The grasses were principally pinehill bluestem (*Andropogon divergens*), slender bluestem (*A. tener*), paintbrush bluestem (*A. ternarius*), broomsedge bluestem (*A. virginicus*), and several associated species of *Paspalum* and *Panicum*.[1]

Year-old nursery-produced slash, loblolly, and longleaf pine seedlings were planted in February 1948 at a spacing of 6 by 6 feet. In March 1948 the oak trees were treated at two intensities and by two methods of control—girdling and poisoning with Ammate (ammonium sulfamate). No clearcut differences in pine or grass growth due to methods of control have been observed

[1]Cassady, John T. Bluestem range in the piney woods of Louisiana and east Texas. Jour. Range Mangt. 4: 173-177. 1951.

so far. The intensities of oak control were: (1) partial release—all hardwoods over 3.0 inches d.b.h. treated; and (2) complete release—all hardwoods over 0.5 inch d.b.h. treated.[2]

Herbage production inventories were taken in August of 1948, 1949, and 1950, at the height of the first, second, and third growing seasons following hardwood control. Production was measured by clipping all grass and forbs near the ground from randomly located plots 3.1 feet square. Air-dry weights were obtained for grass and forbs separately, and converted to pounds per acre.

Results

Table 1 summarizes grass production in 1948, 1949, and 1950 and the initial density of oak trees on 24 treated and 6 untreated ¼-acre plots, all planted to pines. The scrub oak stands were effectively destroyed by all control treatments. No data are available on grass production prior to treatment of the oaks. However, samples taken in a similar scrub oak area in 1946 showed about 750 pounds of grass per acre. The 1948 production was below normal because it was a dry year.

The benefits of hardwood control were evident the first season after treatment. The pine response has been reported by Muntz.[2] Grass on the treated plots was conspicuously greener and remained green later in the summer than on untreated areas. In 1948 there was 22 percent more grass on the treated areas than on the check areas; 90 percent more in 1949, and 111 percent more in 1950.

For the three years, production on treated plots increased from 704 to 1,886 pounds per acre, while the untreated checks increased only from 577 to 892 pounds. Some of the increase on untreated plots may have resulted from border effects, since the plots were contiguous.

TABLE 1.—INCREASE IN GRASS AFTER CONTROL OF SCRUB OAKS (ALL FIGURES ARE PER ACRE)

Hardwood treatment	Initial basal area of oak trees	Annual grass production			Increase from 1948 to 1950	
		1948	1949	1950		
	Sq. ft.	*Pounds*			*Pounds*	*Percent*
Partial	41.6	692	1,606	1,738	1,046	151
Complete	34.9	716	1,456	2,036	1,320	184
All treated	38.3	704	1,531	1,886	1,182	168
Untreated checks	36.4	577	804	892	315	55
Difference		127	727	994		

The striking response of pines and grass after release from overtopping hardwoods can be appreciated only by those who observe treated areas for several seasons. It is similar to the effect of a good fertilizer added to crops on an impoverished soil. It has been suggested that the ammonium sulfamate gets into the soil, loses its poisonous quality, and releases plant nutrients. However, the stimulation appears to be just as great under trees merely girdled as under trees poisoned with the chemical.

Before treatment, the grass was very thin under hardwood thickets. But in the first season following treatment, individual grass clumps grew robust, achieved unusual heights, and began to spread. Thus, the grass increase was in two forms—increased density and heavier plants.

Cattle were attracted to the rapidly growing plants, especially the first season after release. Some plots, not measured but observed in this grass study, were set aside for deferred hardwood treatment in 1949 and in 1950. In each year, cattle grazed the treated plots most heavily the first season after treatment. This close grazing resulted in conspicuous browsing of the planted pines. For example, an inventory at the end of the first year showed that 41 percent of the loblolly pine and 24 percent of the slash pine had been browsed by cattle on the treated plots, as compared to 12 and 5 percent on the untreated plots. This browsing looked severe on some seedlings. However, no mortality could be attributed to it, and evidence of damage disappeared during the second and third growing seasons.

Forest managers must often decide whether or not to exclude cattle grazing from young pine plantations. If grazing is excluded, dry grass will accumulate and form a high fire hazard. Evidence so far indicates that in the Coastal Plain, properly managed cattle do not significantly damage pine seedlings and the grazing reduces grass, a potential fuel, 40 percent or more.

Value of Hardwood Control for Grazing

Grass produced on the treated plots in 1950 was sufficient to provide about 38 cow days of grazing per acre, if utilized 40 percent, compared to only 18 cow days per acre on the untreated plots. This represents an increase of 20 cow days grazing per acre. It usually requires 10 years or more for a successful pine plantation to reach the stage where competition and pine litter reduce grass production significantly. Thus, it is estimated that the increased forage production due to hardwood control will total 6 to 7 cow months of grazing per acre during the first 10 years after planting and control. With good management, the increased income from grazing could repay a major part of the cost of hardwood control, even before returns from pine thinnings start coming in.

[2] Muntz, H. H. Converting scrub oak areas to pine plantations. Jour. Forestry 49: 714-715. 1951.

Yield and Value of Water From Western National Forests[1]

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WATER IS ONE of our most precious resources. It is particularly precious in the West, not because it is more priceless, or needful, or thirst-quenching than elsewhere in the country, but because less snow and rain fall. The Weather Bureau tells us that, for the nation as a whole, the average annual precipitation is 30 inches; for the 27 states east of the Mississippi, 44 inches; for the 11 westernmost states east of the Mississippi, 44 is drier and for longer periods, evaporation is higher in the West than in the East so that the available water does not go as far.

The pressures upon water supplies in the West are mounting. Many more people are using more water, for many more purposes. Population has soared: during the last decade the population of the 11 western states increased 40 percent, from 13.9 million to 19.4 million. More water is used: fifty years ago the per capita use of water in communities was perhaps 8 gallons a day for domestic purposes—modern requirements and plumbing have increased this figure to 30 to 50 gallons a day (*9*). Water is used for more purposes: western industrial growth has made many new additional demands on available supplies; Geneva Steel in Utah uses 10 million gallons of water daily, equivalent to the needs of 150,000 people. In addition some cities, such as Los Angeles, San Diego, and other southern California communities have become important industrial centers.

Such demands account for the West's growing interest in water. They help explain the dams, costly aqueducts, declining ground water, reuse of sewage, interest in reclamation of sea water, widespread cloud seeding, and the annual concern over the depth of the annual snow pack. It is also behind the reason why the relation of western national forests and associated lands to water supplies is assuming more importance.

Not all of the West is parched. Based on Thornthwaite's climatic classification (*5*), 35 percent is classed as humid (Table 1). The greater part of this is in the Cascade, Sierra, and Rocky Mountain ranges. Of the remaining 65 percent, 22 percent is arid while 43 percent is semi-arid. On a state basis, the three Pacific coast states plus Idaho form the wettest unit, the humid area per state varying from 56 to 68 percent. In ascending aridity the northern three Plains-facing states come next. In Colorado, Wyoming, and Montana, humid areas are 46, 35, and 26 percent respectively; while semi-arid land, 51, 59, and 74 percent, takes up most of the rest of the area. A still drier unit, composed of New Mexico, Utah, and Arizona, forms a third group in which the humid area is reduced to 16 to 18 percent with the trend toward aridity in the order named. Nevada, lying in the rain-shadow of the coast ranges and west of the central Rockies, is the driest of all.

TABLE 1.—CLIMATIC CLASSIFICATION OF THE 11 WESTERN STATES[1]

State	Percentage of state area in climatic class		
	Humid	Semi-arid	Arid
Washington	68	22	10
California	57	14	29
Oregon	56	32	12
Idaho	56	32	12
Colorado	46	51	3
Wyoming	35	59	6
Montana	26	74	0
New Mexico	18	65	17
Utah	16	52	32
Arizona	16	41	43
Nevada	0	33	67
Mean[2]	35	43	22

[1]Values obtained by planimetering Thornthwaite's map *Moisture Regions in the United States* (*4*), but combining "perhumid to dry subhumid" climatic types into one humid class.

[2]Calculated from total area of states and total class areas.

Paradoxically, despite the emphasis on semi-aridity and aridity, frequent and damaging floods occur. Of these, the 1948 Columbia River flood is perhaps the best remembered, though in other areas, notably California, the Willamette Valley, the Front Range of Colorado, and the Middle Rio Grande, recurrent floods have caused tremendous damage. Even Reno, Nev. was in the flood news this past winter.

Western water supply is not entirely a matter of trickles or torrents. Sufficient precipitation falls not only to supply the domestic needs of almost 20 million people, to irrigate over 17 million acres, to satisfy the heavy demands of an expanding and varied industry, and to grow heavy stands of forest and produce much range, but also to waste great quantities to the seas in floods and unused flow. Currently, no shortage of consequence looms that has not already been overcome by the blueprints of engineers.

No effort and no expenditure appears to be too great. Costs are estimated, not in millions but in billions of dollars. Probably over half of the 100 billion-dollar expenditure estimated by the President's Water Resources Policy Commission as required for national water resource construction will go for dams. Western river basins will receive their share. Hundreds of millions have already been spent and hundreds more authorized. Today, for hydroelectric power and other purposes, 10 million acre-feet of active storage capacity have been provided in the Columbia River basin (*3*). Completion of projects under construction, authorized, and recommended, will increase this total to 25 million, with a potential capacity of 75 million acre feet. In the Colorado River basin, corresponding volumes are 31, 33, and 89 million acre feet. Proposed construction in some present-day boisterous tributaries will turn them into a string of placid lakes.

Reservoirs will store and equal-

[1]Aid and assistance in the preparation of this paper has been rendered by Donald R. Gedney, Herbert C. Fletcher, Kenneth G. Reinhart, and Howard W. Lull of the U. S. Forest Service. The latter two especially have rendered material service in compiling data and in preparing the manuscript.

ize stream flow for power, irrigation, and other uses. They may solve some local problems but are not the answer to all, as some drainages may have insufficient supplies to meet regional population demands or development needs. So, to provide a more desirable distribution of water, some of the flow of tributary, or even main streams, is diverted from their own channels into those of adjacent drainages. In this way it is proposed to transfer some of the waters of the Colorado into five other major basins: the Missouri, Arkansas, Rio Grande, Sevier, and Great Salt Lake drainages. The Souris and Red River of the North are to obtain water from the Missouri. Possibly California will get water for its Central Valley from the Snake River in Idaho. Plans are under way for taking water from the Trinity into the Santos, from the Boise into the Snake, and from the Colorado into the Salt and Gila. Today water from the Colorado River is diverted to Los Angeles, San Diego, and other communities, that of the Tuolomne goes to San Francisco, and that of the Mokelumne River to Oakland and other cities. Water from the Eel now flows in the Russian River in California; and from the Price in the San Pitch, and from the Duchesne in the Spanish Fork River in Utah.

Behind and above all the dams and diversions lies the source of water, the watershed land that receives precipitation in excess of its needs. As yet, this element of the water supply picture has not received and is not receiving a tithe of the attention or a morsel of the worship that has been so bountifully showered upon engineering works. However, realization that water is the critical and limiting resource throughout the West is stimulating a growing interest in its source, behavior, and quality.

Most western water source areas are the humid islands which proudly dominate the arid valleys which stretch their arms always upward for the moisture. The close relation between the mountain ranges and areas of high precipitation is immediately apparent on any map showing rainfall distribution. Attention is also drawn to the fact that most western national forests lie astride of the main mountainous, water-supplying areas. Though, in large part, national forests were reserved for their watershed protective value, ". . . for the purpose of securing favorable condition of water flows . . . ," far too little attention has been paid to the magnitude or value of this flow.

Various estimates of the western water resource have been made in the past. These appraisals generally emphasize the high water yield of wild land or mountainous areas where national forests have been created but give little specific data on amounts. In 1919, Dana asserted that 85 percent or more of irrigation water came from the mountains (*1*). In the *Western Range* (*6*), it is stated that 85 percent of the flow of major western streams comes from four-fifths of the 232 million acres which is range land. Very recently Saunderson (*4*) has made an estimate of water yield from national forests west of the 101st Meridian. His data, based on stream gage records from 19 national forests, are shown for the present Forest Service administrative regions. Other appraisals have been made but usually on a localized basis.

This situation suggested the need for a more detailed determination of the total runoff from national forest areas in the 11 western states. Further, the growing importance attached to drainage basins suggested data be compiled on that basis. Then too, some comparison was needed as to the total amount of runoff from national forest areas as against that from non-national forest lands. Finally, all such information should be related to the precipitation over the drainage or unit area.

Sources of Data

Annual runoff data were obtained from the runoff map prepared by Langbein and others of the Geological Survey (*2*). This map was enlarged from a scale of approximately 1 inch to 150 miles to 1 inch to 40 miles. A tracing was made of runoff isograms from each state, and the tracing placed over a map of identical scale showing the exterior boundaries of national forests. Areas enclosed by national forest boundaries and by the isograms were planimetered. Average runoff values for the national forest areas and for the lands outside the national forests were calculated by weighting the delineated areas by their runoff value, summing the runoff-area values, and dividing by the area.

Annual precipitation data were obtained in the same manner as those for runoff. The best available maps of annual rainfall by states (*8*) were enlarged to a scale of 1 inch to 40 miles, and the areas enclosed by national forest boundaries and by isohyetals were planimetered. The average precipitation values were obtained by areal weighting. Areas of national forests used in both runoff and precipitation calculation are gross values, as boundaries planimetered include small areas of non-national forest land, private and public.

Runoff, as used by Langbein and here, is the natural discharge of water in surface streams and does not reflect reductions due to such causes as diversion, riparian transpiration, and evaporation from the water surface of streams. Runoff and precipitation are expressed in both depth in inches and as percentage of total volume for the areas considered. Runoff depths were taken directly from the runoff map. Volumes used in determining percentages were calculated by multiplying area by depth.

The accuracy of the runoff and precipitation values presented here is difficult to assess. The sources of data are the best of their kind. Of the two sources, the runoff data are believed to be the more accurate as they are based for the most part on streamflow measurements and thus on total volume of water. Precipitation data, on the other hand, are subject to considerable error as many areas of high precipitation are not sampled at all. Also, because they originate from measurements at definite points they can provide only an index of total

TABLE 2.—PRECIPITATION AND RUNOFF FOR NATIONAL FOREST AND NON-NATIONAL FOREST AREAS IN THE 11 WESTERN STATES

State	Gross area		Average annual precipitation					Average annual runoff				
			Depth			Volume		Depth			Volume	
	NF	Outside NF	Whole state	NF	Outside NF	NF	Outside NF	Whole state	NF	Outside NF	NF	Outside NF
	Percent	*Percent*	*Inches*	*Inches*	*Inches*	*Percent*	*Percent*	*Inches*	*Inches*	*Inches*	*Percent*	*Percent*
Arizona	16	84	12.0	18.4	10.7	25	75	0.7	1.5	0.5	37	63
California	25	75	21.2	34.5	16.8	41	59	8.6	19.2	5.0	57	43
Colorado	23	77	16.0	19.6	15.0	28	72	4.4	11.4	2.2	61	39
Idaho	40	60	18.1	23.5	14.4	53	47	8.5	14.7	4.3	70	30
Montana	21	79	14.7	17.5	14.0	25	75	4.4	12.2	2.4	58	42
Nevada	8	92	8.1	9.7	8.0	9	91	0.5	1.1	0.5	16	84
New Mexico	13	87	14.4	16.6	14.0	15	85	0.6	1.7	0.5	36	64
Oregon	29	71	27.9	38.6	23.6	39	61	14.4	21.7	11.4	44	56
Utah	17	83	10.8	15.7	9.7	25	75	2.0	6.5	1.0	57	43
Washington	26	74	39.1	59.3	32.3	38	62	17.8	31.1	13.2	45	55
Wyoming	15	85	14.1	18.2	13.4	19	81	4.1	14.7	2.2	54	46
Mean[1]	21	79	17.2	26.2	14.8	32	68	5.5	14.0	3.3	53	47

[1]Calculated on basis of area, not states.

water volume.

Only by use of such sources of data is it possible to compare runoff and precipitation from national forest areas and non-national forest areas for as large a region as that considered. There are not now, nor are there likely to be in the near future, sufficient precipitation and streamflow gages on these two broad types of land area to permit a more direct comparison of runoff and precipitation.

Water Yield

Runoff and precipitation by national forest[2] and non-national forest areas within individual states are given in Table 2. The more important points are as follows:

1. National forest areas comprise 21 percent of the area of the 11 western states, receive 32 percent of the total precipitation, and furnish 53 percent of the total annual runoff.

2. Average annual precipitation for national forest areas amounts to about 26.2 inches, and for the lands outside national forests, 14.8 inches. With the latter as unity, the ratio is 1.8 to 1.

3. Annual runoff from the national forest areas is 14.0 inches and from outside areas 3.3 inches, giving a ratio of 4.2 to 1.

Supplementary calculations show that

1. For the entire West, 32 percent of the precipitation appeared as runoff; from national forests 53 percent, outside national forests 22 percent.

2. The difference between measured precipitation and runoff is very nearly equal for each class of land (26.2 — 14.0 = 12.2 inches; 14.8 — 3.3 = 11.5 inches).

Table 3 provides similar information for certain major drainage basins. It also discloses that about one-half of the annual runoff is derived from national forest areas. Striking is the fact that the three great western rivers, the Columbia, Colorado, and Rio Grande, derive almost equal percentages of runoff from national forest areas.

The isograms on the runoff map show runoff at the point of origin and, as pointed out, do not reflect streamflow reductions due to various causes such as by riparian transpiration, evaporation, and diversions. Because of this, total annual runoff in this table exceeds the total runoff calculated from a stream gaging record at the mouth of a watershed. For instance, based on the estimated annual flow of the Colorado River at the International Boundary of 17.7 million acre-feet, the annual runoff is only 1.4 inches, considerably less than the 2.5 inches given in Table 3.

The higher amounts of precipitation on and of runoff from national forest areas are primarily due to the high elevation at which the forests are located. Air masses moving principally in an easterly or southeasterly direction must pass over the mountain ranges lying across their path. Forced upward, the air is cooled and the moisture condensed and precipitated as rain or snow. The mountains which comb the moisture out of the air masses have been aptly described as "humid islands." Forests on the "islands" are therefore an effect,

TABLE 3.—RUNOFF FOR NATIONAL FOREST AND NON-NATIONAL FOREST AREAS IN CERTAIN WESTERN DRAINAGE BASINS

Drainage basin or area	Area		Average annual runoff				
			Depth			Volume	
	NF	Outside NF	Whole area	NF	Outside NF	NF	Outside NF
	Percent	*Percent*	*Inches*	*Inches*	*Percent*	*Inches*	*Percent*
Columbia (in U.S.)	37	63	10.4	16.7	6.7	59	41
Colorado (in U.S.)	19	81	2.5	7.2	1.3	56	44
Rio Grande above El Paso	25	75	1.7	3.8	0.9	58	42
Central Valley (Calif. only)	32	68	11.8	23.5	6.4	63	37
Rogue-Umpqua area	40	60	35.5	37.0	34.2	42	58
Northwest Washington (State less Columbia)	32	68	39.3	51.4	33.7	41	59
Southern California coast (Los Angeles watershed to Mexican border)	25	75	3.7	6.3	2.8	43	57
North Platte and South Platte	11	89	1.7	6.2	1.2	41	59
Missouri above Ft. Randall Dam	9	91	1.7	6.9	1.2	37	63
Arkansas above Dodge City	9	91	1.2	4.7	0.7	38	62
Great Salt Lake and Sevier Lake	23	77	2.8	6.2	1.8	52	48

[2]Includes lands outside of Forest Service administration amounting to 11.5 percent of gross national forest area.

not a cause of the greater amounts of precipitation that fall on them.

In this discussion, attention has so far been directed only to the total quantity of water derived from the western national forest areas. This total includes all that utilized in the Western economy as well as that wasted to the sea in excess flows. Data are not yet available by which one can determine with reasonable precision, how much of the total supply used in this economy can be traced to national forest sources. Various devices have been resorted to, in an effort to provide a reasonable estimate of the portion of the total so utilized which comes from these areas. The results of these calculations indicate that at least 80 percent of all the water consumed in western agricultural, industrial and domestic development comes from the national forest areas.

Water Value

National forest water has a far higher value than that from other lands, not alone because of greater volume, but also because of the timeliness of its delivery and its high quality. A considerable volume of national forest water is available for use in the late spring and early summer season when runoff from the lower lands has disappeared. It forms, as a rule, the base for most agricultural use downstream. Such water is also of high quality because it passes through soils in which there is very little accumulation of deleterious salts. This is in decided contrast to the water originating in other areas which picks up such salts concentrated by evaporation in many surface soils. Residents of the western states do not care for this low quality water for industrial, domestic, or agricultural use.

The monetary value of the runoff from western national forest areas may be estimated in a number of ways according to the uses made of the water resource. Annually, the runoff amounts to 184 million acre-feet. Considering an acre-foot of water as having a value of only $3 to the irrigation farmer,[3] the total annual runoff is worth $552,000,000. Or supposing that 10 percent of this runoff is consumed by domestic or industrial users who will pay 10 cents per thousand gallons, this value alone would be nearly $600,000,000. Obviously, these annual values far exceed the dollar value of all the other products from the national forest areas.

A recent conservative comparison of the annual value of water and forest products from all national forests gave the following results (7):

Recreation and wildlife	$ 25,000,000
Water	300,000,000
Free permits for timber, range, etc.	1,000,000
Cash receipts to the Treasury	32,000,000
Other monetary returns	4,000,000
Increase in net growth and inventory revaluation	50,000,000
Total annual returns	$412,000,000

On this basis, water values compose about 75 percent of the total. However, we should note that the water value given above is only half that provided in the preceding estimates. Should the water value as derived previously be used, the aggregate of the tabulation would be $712,000,000, in which the water values would constitute about 85 percent of the entire sum.

Estimates of this nature pose the question: Why should water values be assigned to these forest areas, as water would naturally flow from them? The answer is simple. If water is to have a value, it must have certain properties—and these in great measure are derived from the protection provided by a forest cover. Water must be available at the right time, in the right volume, and in the right quality. A major justification of public management is that properly conserved and used, these lands provide the environment under which these properties become most effective.

Forests act on water through soil. A stable environment signifies a stable soil. Soil that is kept on the land is kept out of the water. Water-carried soil material clogs irrigation ditches, fills reservoirs, clogs municipal filtering devices, reduces fish and wild life, and in other ways causes damage and losses to the user. Protected, the soil permits unchecked movement of water into and through it, yielding water to underground reservoirs and passageways to provide stable, timely flow. Reduction of flood crests saves water, lending constancy to water volume.

Forest vegetation is not the only type of cover that has a beneficial effect on water supplies. Any other type of vegetation, herbaceous or shrub, or mixtures of types could serve the same end. But, because of the close relation between forest cover and source of water supplies and between litter and soil, the value of forest cover is much greater than of other types. This, in turn, makes the relation between forests and water of tremendous national concern; in the western states it emphasizes the value of national forests.

The value of national forests to water supply is steadily increasing. Development of hydroelectric power in national forests is a good example. Of some 750 potential power sites in western national forests, 311 have been developed. At these plants generators of nearly 3 million horsepower capacity have been installed: slightly over one-third of the capacity developed in the 11 western states. At 88 of these sites large reservoirs have been built to produce power exclusively. In addition, over 230 small dams have been built to divert water into pipelines or canals for power production. In addition, 127 reservoirs have been built for multiple-purpose use, including hydroelectric power. All of these dams and reservoirs are protected from excessive sedimentation by the national forests. On the basis of continuing increase in construction costs necessary to replace the structures, these protective benefits are steadily increasing. Further, the growing western

[3] G. D. Clyde in the April 1951 issue of the *Journal of Soil and Water Conservation* indicates a value of water for irrigation ranging from $6 to over $60 an acre foot.

dependence on cheap hydroelectric power, the limited number of reservoir sites, the fact that these sites are nonrenewable natural resources, all highlight the present high protection value of the national forests and their increasing future value.

More than protection, however, is needed to realize the full benefits of national forests on water supplies. Protection is necessary. From the protection the national forests have received already have come invaluable public benefits. But protection alone is no more the means of achieving water resource management than it is of getting forest management. And that is not all. Even water resource management cannot be the entire answer, for it lays undue stress on one resource, a policy contrary to the widely accepted policy of multiple-use management tightly into the production of high quality water.

of national forests. This precludes solely timber management or water resource management or range management. What is required is to fit water resource management into multiple-use management of national forests.

Watershed management is the answer. Under conscious watershed management, the water resource can take its proper place among other resources of the national forest. Like timber and range resources, it will some day be measured and inventoried, and more specifically protected and managed. Only a bare beginning has been made in this direction. But as interest and concern over western water resources grow, the national forests of necessity will become more and more identified with the water supply, and their management increasingly tied

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Reducing Wildlife Hazards in Dutch Elm Disease Control

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THE AMERICAN ELM, a valuable shade and landscape tree, is seriously threatened in certain areas by the Dutch elm disease. The importance of this tree in urban environment in some parts of the country is indicated by the fact that in the Borough of Princeton, N. J., where special studies have been conducted on Dutch elm disease control, there are about 2,580 elms. The loss of even a small portion of these could substantially reduce the attractiveness of the community. Also, the cost of removal of dead trees, either by public agencies or by private citizens, would be high.

This introduced disease is caused by a fungus, *Ceratostomella ulmi*, which is spread by bark beetles carrying spores from infected trees. Beetles breed in diseased elms and a new generation of the insects spreads out in the spring to feed on healthy growth. In the eastern United States, the native elm bark beetle (*Hylurgopinus rufipes*) and the smaller European elm bark beetle (*Scolytus multistriatus*) are important carriers, the latter particularly so. It has been found possible to provide a fair degree of protection from Dutch elm disease by spraying with DDT. Many bark beetles carrying infectious spores are killed by the DDT residues before they can contaminate healthy trees. However, as in many other control operations involving insecticides, such spraying, if widely adopted, introduces the possibility of serious damage to wild birds and mammals. The need, therefore, is for methods of safeguarding the trees in a manner least harmful to wildlife.

Recent tests by the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture (1947-1950), have been conducted at Princeton to determine whether Dutch elm disease control with DDT is practicable on a community-wide basis. During initial phases of the tests, reports of some bird and squirrel mortality were received. Since 1949, the U. S. Fish and Wildlife Service has cooperated with the Bureau of Entomology and Plant Quarantine in trying to ascertain the extent of wildlife losses, and the possibilities of modifying spraying programs so as to minimize undesirable effects on wildlife without seriously impairing efficiency of beetle control.

In the three years 1948-1950, spraying programs have included two phases of application: a spring (March-May) prefoliar treatment with 2 percent DDT and a summer (June or July-August) application of 1 percent strength. This report deals mainly with the 1950 studies but its generalizations are based partly on the 1949 investigations by Benton.[2]

Census studies on wildlife species were made before and after spray-

[1] In cooperation with Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Princeton University, Borough of Princeton, and residents of Princeton, N. J.

[2] Benton, Allen H. Effects on wildlife of DDT used for control of Dutch elm disease. Jour. Wildlife Mgmt. 15 (1): 20-27, 1951.

ings in an effort to appraise population trends. These studies included ten pre-spray and ten post-spray censuses on each of four study areas: two of them sprayed and two of them unsprayed checks. Also, mortality surveys were conducted to determine the extent of losses within an intensively studied part of the sprayed area. While evidence indicates that in a few cases the animals found dead were not victims of DDT, it was manifest that a vast majority of them died from poisoning. Twenty-six sick birds were subjected to close observation and in all but one of these, typical DDT-poisoning symptoms, described in detail in the literature, were exhibited, and the birds died within a few hours. Far heavier mortalities among birds were encountered in connection with spring spraying than in summer. Also, it was found in both 1949 and 1950 that adult birds were much more vulnerable to a 2-percent solution of DDT than to a 1-percent solution. Mortality findings in the spring of 1950 are summarized in Table 1.

TABLE 1.—MORTALITIES IN PART OF THE PRINCETON BOROUGH FOLLOWING SPRING SPRAYING IN 1950

Dead birds collected	
Robin	35
Myrtle warbler	31
Wood thrush	6
Rose-breasted grosbeak	5
Pine siskin	5
Goldfinch	5
Junco	4
House sparrow	4
Purple grackle	3
Cedar waxwing	3
Black-throated Green warbler	2
Black and white warbler	2
Oven-bird	2
Scarlet tanager	2
Miscellaneous (1 each of 13 kinds)	13
Total	122
Additional dead birds reported but not collected	81
Total birds collected or reported	203
Estimated dead birds in borough[1]	546
Dead mammals collected	
Gray squirrel	5
Cottontail rabbit	1
Common mole	1

[1]Based on sampling tests indicating that for every 10 dead birds reported by cooperators an average of 42 was actually found.

Spring birds feed voraciously as a result of their migratory effort. If their food is highly contaminated by DDT and if the body fat of the birds, which ordinarily stores large amounts of the toxicant, is at a minimum, these migrants are susceptible to acute poisoning. In the spring studies of 1950, robins and myrtle warblers, of which 35 and 31 specimens respectively were found, appeared to be the most common victims of the spray. Robins are ground feeders and evidently obtained the toxicant from standing water and contaminated food. Myrtle warblers, on the other hand, were observed to be feeding in the crown canopy of the elms some 50 to 60 feet from the ground. Both species seem particularly subject to losses because of their feeding habits and their abundant numbers at the time of spraying. In contrast to this, a later spraying, after most of the migration has been completed, is less likely to be destructive. The foliar application of 1949, for which a 1-percent DDT application was used, resulted in the known mortality of only 26 birds, most of which were young individuals. After the corresponding spraying in 1950, practically no losses were evident.

The pre-foliar application of DDT was made with a 2-percent emulsion, which was put on with a hydraulic spray. The large volume, high concentration, and method of application were believed to be instrumental in causing bird and mammal mortality. When a hydraulic rig is used, the greater volume of spray is directed toward the crown of the tree. Each tree receives 15 to 20 gallons of spray, 42 percent of which is estimated to be run-off. This creates puddles of insecticides beneath trees, contaminates run-off, and deposits 130 to 196 pounds of DDT per acre in the top 3 inches of soil. As a result, wildlife food, drinking water, nesting material, and grit are contaminated. Studies conducted during the 1949 foliar application and the 1950 pre-foliar application of DDT indicated that immediate wildlife losses may be reduced by certain adaptations in methods of spraying. The long-term effects of heavy dosages of DDT, however, are not as yet evident.

The use of a mist-blower for spray application resulted in a noticeable reduction of mortality for those areas in which it was used. This may be due to the fact that run-off and drip were largely eliminated and the waste DDT was dissipated over a wider area. The chances of contamination of food and drinking water for wild animals were greatly reduced by this method of spraying.

On the basis of the 1949-50 studies at Princeton, certain recommendations can be made to minimize wildlife mortality without seriously reducing the effectiveness of programs for Dutch elm disease control. For the pre-foliar application of DDT, it is recommended that operations begin as early in the spring as weather conditions will permit. At the latitude of Princeton, the critical date would be approximately April 15. In this way, the first spray will have been applied prior to the arrival of migratory birds. Entomologists have found that dried or crystallized residues of certain DDT formulations control bark beetles for several weeks following a spraying. For the foliar application, spraying should be delayed until the middle of July. At this time, because of the favorable condition of young individuals and less vulnerability to the 1-percent spray, mortality is likely to be substantially decreased. Use of the mist-blower is recommended wherever practicable. During actual application of the spray, care should be taken to cover places such as fish ponds and bird baths. In residential areas, the flushing and sweeping of street gutters is advisable.

Research is now in progress which may offer new and better methods of controlling Dutch elm disease. Among these are the injection of chemicals into the soil around the roots and into the tree trunk. Although still in experimental stages, such chemo-therapeutic methods offer some hope for the preservation of both trees and wildlife. In the meantime, DDT spray, applied in accordance with precautionary measures recommended here, appears to be the most effective control agent.

Use of Allyl Alcohol for Weed Control in Forest Nurseries

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ALLYL ALCOHOL promises to reduce weeds in forest nursery beds. It has potential use where early weed growth, for various reasons, cannot be handled by spraying with mineral spirits. It is, however, dangerous to handle and has certain other limitations.

Allyl alcohol is a clear light-amber liquid, with the empirical formula of C_3H_5OH, a molecular weight of 58.08 grams, and specific gravity of 0.855 (equivalent to 7.1 pounds per gallon). It is very soluble in water, and is moderately volatile and inflammable, having a boiling point of 97.1 degrees C. and a flash point of 90 degrees F. The vapor, which has an acrid, radish-like odor, is extremely irritating to the eyes, nose, and throat. If allyl alcohol gets on the skin, it should be immediately washed off with soap and water. Anyone working with it should wear rubber gloves, boots, a rubber apron, and a gas mask which has goggles covering the eyes.

In tests at the Harrison Experimental Forest and the Ashe Forest Nursery in southern Mississippi, the alcohol has first been dissolved in water, usually 1 volume of alcohol to about 208 volumes of water. On small plots, this solution has been simply sprinkled from cans at the rate of 1 quart per square foot. In large-scale tests, it has been applied by gravity feed, from a tank mounted on a tractor-drawn dolly, at the rate of 10,940 gallons per acre of nursery bed space.

TABLE 1.—WEIGHT OF WEEDS FROM 208 SQUARE FEET OF BED AREA TREATED AND NOT TREATED WITH ALLYL ALCOHOL

Year	Not treated	Treated	Ratio (untreated beds ÷ by treated)
	Grams	Grams	
1950			
Fresh weight	4,761	37	129
Dry weight[1]	1,017	9	113
1951			
Fresh weight	24,225	1,861	13
Dry weight[1]	3,179	410	8

[1]Weeds dried at 70°C. in forced draft oven.

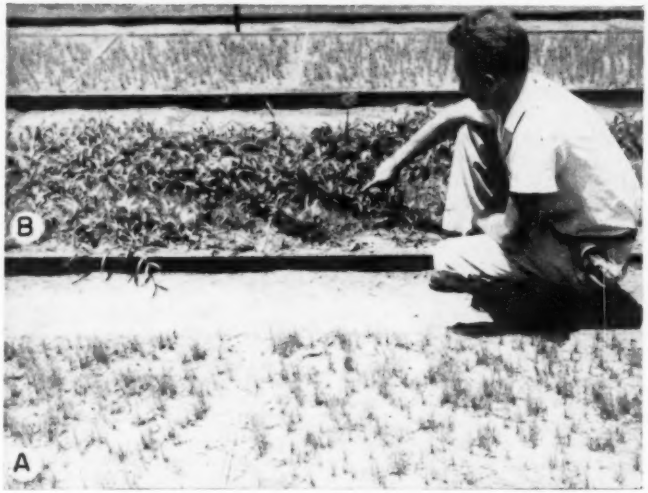

FIG. 1.—Five days before it was sown, Bed A was drenched with allyl alcohol solution at the rate of 50 gallons of the alcohol per acre. Bed B was not treated. Otherwise, plot in right foreground of Bed A received identical treatment with plot at right in Bed B, except for a heavier superphosphate dosage (which should have encouraged weed growth). The curb boards prevent heavy rain from washing weed seeds into the beds from outside. Photo taken in 1950, 50 days after sowing and just before first weeding was made.

To prevent injury to pine seed the drench has been applied at least 3 days before sowing. After application, the beds have been left undisturbed to avoid dredging up weed seeds from untreated layers of soil, but shallow raking to break the surface crust immediately before sowing usually has been desirable.

Observations and Measurements

Allyl alcohol was first applied to the Harrison Experimental Forest nursery beds just prior to spring sowing in 1948. Since then, the treatment has been repeated on the same beds before sowing in 1949, 1950, and 1951 without any sign of injury to germination or growth of pine seedlings. No serious damping-off injury has occurred in any of the past 4 years, and seedling stands have been excellent each year in all beds sown with seed of satisfactory soundness.

Control of weeds has been especially good. This is illustrated by records on two adjacent beds, one drenched in both 1950 and 1951, and the other not at all. Although the two beds are not strictly comparable because of some differences in fertilizing, enough plots were treated alike in both beds to provide a valid comparison of weed growth (Table 1).

The first weedings in 1950, approximately 50 days after sowing of pine, revealed a large difference in amount of weeds between the treated and adjacent untreated bed (Fig. 1). In the 1951 season, the first weedings from the same beds, nearly 70 days after sowing of pine, also showed appreciable differences, although not so striking as in 1950. The longer interval between sowing and weeding in 1951, as well as other factors, may account for the smaller differences in the second year.

During the entire 1950 season, 8 man-hours were expended in weeding the untreated bed (208 square

TABLE 2.—EFFECT OF ALLYL ALCOHOL ON FALL-SOWN LONGLEAF PINE, ASHE NURSERY, 1947[1]

Treatment	Seedling density per square foot		Average green weight per Plantable	First year field survival
	Total	Plantable		
	Number		*Grams*	*Percent*
Untreated control	26.4	23.5	12.74	79.5
Allyl alcohol				
180 pounds per acre	28.6	25.9	12.66	78.5
360 pounds per acre	26.6	24.6	12.83	81.5

[1]Test installed in cooperation with Division of Forest Pathology, Bureau Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture.

feet) while only 1¼ man-hours were spent on the adjacent alcohol-drenched bed. In 1951, the first weeding of the treated bed required less than 1 man-hour in contrast to over 4 man-hours for the neighboring untreated bed. In 1947, when allyl alcohol was not used at all, about 12 man-days were spent weeding 1,040 square feet of bed surface. In 1948, when all beds were treated, only 3½ man-days were spent weeding 1,456 square feet of bed surface. These differences accord with the earlier findings of Lindgren and Henry,[1] who observed that a deep alcohol drench gave striking control of weeds until mid-June, eliminating need of two early weedings and making subsequent weeding much easier.

The effect of the alcohol drench on quality of seedling stands and the performance of seedlings after planting was measured at the Ashe Nursery, Brooklyn, Miss. These tests showed no detrimental effects of allyl alcohol on density per square foot, average green weight per seedling, or first-year survival of longleaf pine seedlings (Table 2).

In contrast to the Harrison Nursery (where curb boards are regularly used to protect beds from erosion) weed control on alcohol-drenched beds at the Ashe Nursey has not been consistent. Failures have been attributed largely to downpours that caused run-off waters to surge over treated beds (which have no curbs), thereby introducing weed seeds from untreated areas. Winds could cause similar contamination if weedy areas are not kept scrupulously mowed before seeds mature. Repair of beds after rains frequently has involved spading deeper than the treated zones, and thus digging up viable weed seeds.

In large-scale trials at the Ashe Nursery drenching the beds by gravity feed has been slow. Treating an acre of nursery beds (18 beds, each 400 feet by 4½ feet) takes a full day, because each bed requires four trips to assure adequate infiltration. Two other methods of application are considerably faster, although their relative effectiveness has not been measured. One involves applying a concentrated solution of allyl alcohol directly to the beds and then watering with the overhead system to disperse the alcohol through the surface soil. The other employs the overhead water system direct to apply the diluted alcohol solution by sprinkling. This latter method has been used successfully through a special adaptation in a western nursery.[2]

Summary

Allyl alcohol (CH_2:CH CH_2OH) has been used at one small Mississippi nursery successfully over a 4-year period, (1948-1951).

It has reduced early weed populations, and it has not impaired field performance of seedlings.

The chief drawbacks are that it takes time to apply, requires a lapse of at least 3 days between treatment and sowing, and that heavy rains and wind may contaminate bed surfaces with weed seeds after treatment. Fairly elaborate precautions are essential for safe application.

[1]Lindgren, Ralph M. and Berch W. Henry. Promising treatments for controlling root disease and weeds in a southern pine nursery. Plant Disease Reporter 33 (5): 228-231. May 15, 1949.

[2]Lanquist, Karl. Allyl alcohol application through the overhead sprinkler system. Tree Planters' Notes No. 7, 12-13. Forest Service, U. S. Dept. Agr. September 1951.

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Prize winning dairy herds on the Carnation Milk farm in Snoqualmie valley.

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The Effect of Pruning on the Height and Diameter Growth of Loblolly Pine

Harold E. Young and Paul J. Kramer

Respectively, assistant professor of forest mensuration, University of Maine, Orono, and professor of botany, Duke University, Durham, N. C.

FORESTERS have made many studies of height and diameter growth of trees. Few if any simultaneous measurements of growth in diameter and height have been made, however. Furthermore, diameter growth has usually been measured only at breast height. It seemed to the writers that more could be learned concerning the growth processes of trees by simultaneously measuring height growth and diameter growth at several positions on the tree trunk. Measurement of diameter growth at various heights above the ground would show whether or not differences occur in growth rates at various positions on the trunk.

The study was made on loblolly pine trees (*Pinus taeda* L.) growing in a plantation on the Duke Forest. These trees had been planted 13 years prior to this experiment as 1-0 stock. At time the study was made they were 32 to 37 feet in height, with an average diameter at breast height of 6 inches. Tall trees were selected for this study to provide an opportunity for measuring diameter growth at significantly different heights and to permit study of the effect on growth of removing various fractions of the crown. The crowns of the trees occupied about 50 percent of their total height. Normally stocked stands in the eastern part of the United States consist of trees whose crowns range from a maximum of 50 to a minimum of 20 percent of their height; therefore, the experimental trees were pruned in the spring of 1946 so the amount of crown left was 20, 35, and 50 percent of total tree height. The trees subjected to these treatments are hereafter identified as Class 20, Class 35, and Class 50 trees. They provided an opportunity to measure the contribution of various fractions of the crown to height growth, and to diameter growth at various points along the tree trunk.

Methods[1]

Six blocks of three dominant trees were selected with special care that the three trees within each block be as uniform in size and general appearance as practicable. The three treatments were then assigned to the trees within each block strictly at random. The major initial differences were therefore among blocks of trees, and these differences are eliminated because the experimental comparisons are made among treatments within blocks. Sufficient branches were removed from each tree to make it conform to the crown length class to which it had been randomly assigned. The percentage of crown left was based on the point of origin of the branches on the trunk, rather than on the position of their tips since the former

[1]The authors wish to acknowledge the assistance of Professor F. X. Schumacher in designing this experiment.

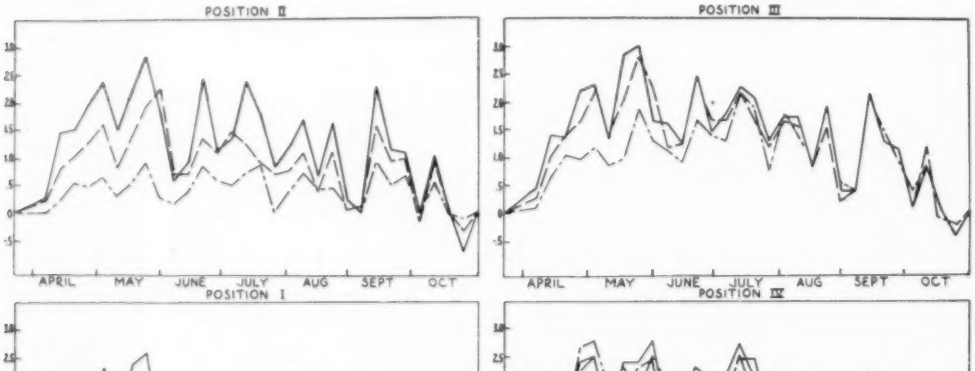

FIG. 1.—Average weekly increase in tree diameter during the 1947 growing season in hundredths of inches at each of four positions, according to crown length class.

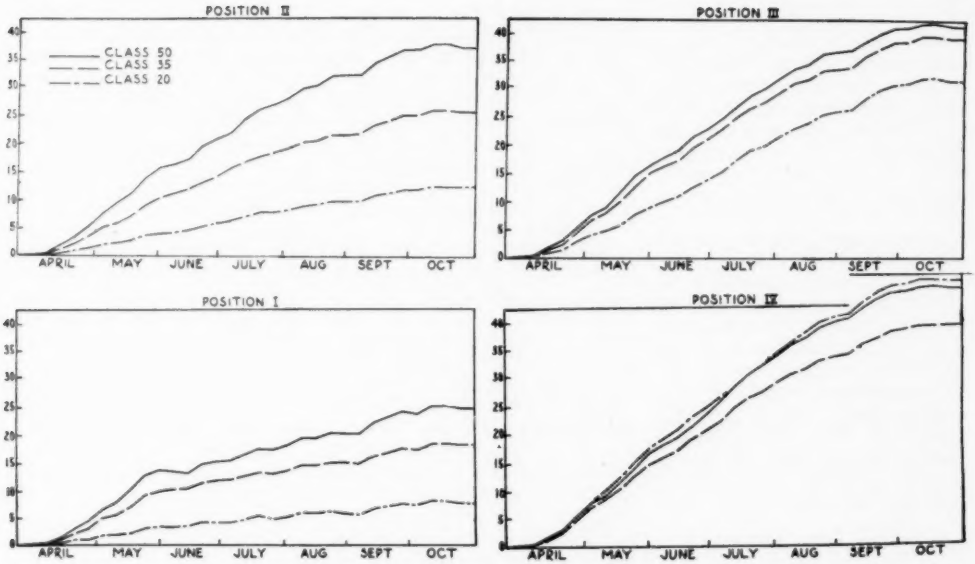

FIG. 2.—Average diameter growth per tree during the 1947 growing season in hundredths of inches at each of the four positions, according to crown length class.

basis allowed more precise measurements. Since very few branches were removed from the Class 50 trees, they can be regarded as practically unpruned controls.

Diameter growth was measured by use of the tree ring bands described by Hall (*6*) and by Liming (*8*). These were modified from the original descriptions by changing the markings on the vernier so that measurements were made from below, because it was easier to read them in this position. The rings were located at four positions along the trunk, the first at the conventional breast height, 4.5 feet above the ground (Position 1), a second at 50 percent of tree height (Position 2), a third at 65 percent of tree height (Position 3) and the fourth at 80 percent of tree height (Position 4). At the two lower positions the bark was smoothed with a rasp to provide a smooth surface for the bands, but vigorous rubbing with the hand sufficed at the upper positions. If a whorl of branches existed at or near the point where a band was to be placed, the band was attached at least 8 inches below the whorl to avoid interference from the branch.

Height growth was measured with a modification of Liming's sectional pole (*9*). Since transportation was not a problem in our work, a solid bamboo pole 21 feet long was used with a spring mounted horizontally at the tip, but the feathers attached to the spring by Liming to increase visibility were not used because they were too easily damaged. The pole was marked off in 1-foot units and a ruler used to measure inches. A nail was driven into each tree trunk 20 feet above the ground and height was measured from the nail. To measure height, one man stood on a ladder and pushed the pole up through the branches. An observer with field glasses stood on the ground at a distance from the tree equal to its height and directed the man on the ladder so that he brought the spring tip on the end of the pole in line with the terminal bud. The distance from the tip of the bud to the nail was then recorded. Since wind movements affected the apparent height, measurements were made while the stem tip was motionless.

Height and diameter measurements were made each week during two growing seasons. Measurements were started at the beginning of the growing season in 1946 and continued for several weeks after growth had apparently ceased, to make certain that the weekly variations were caused by changes in moisture content and not by growth. In 1947, measurements were made for several weeks before growth started and for a like period after growth ceased.

Some measurements of environmental factors were also made on a weekly basis. Evaporation was measured by two Livingston atmometers located on posts 4.5 feet high, one in the open and the other in the shade. The average corrected water loss from the two bulbs was recorded as the evaporation. A rain gauge was placed in an open area. Vandalism made it impossible to record soil and air temperatures as originally planned. Soil samples were obtained from the A_1, A_2, and B_1 horizons each week, and the moisture content determined by oven drying. The wilting percentage and moisture equivalent of soil from each horizon were determined by standard methods.

Results

The results of this study are presented graphically. Since there was a close similarity between growth in the two seasons, only a portion of the data for the second growing season is included in the graphs. In Figures 1, 2, and 3 the graphs are grouped to permit comparisons between growth at different positions and with different amounts of crown. The circumference measurements have been converted to the following expressions of growth: (1)-weekly growth in diameter, (2)-accumulative growth in diameter during the season, and (3)-accumulative increase in cross sectional area during the growing season. In Figure 4 the height growth for both years is shown. Each of these sets of data will be discussed in detail.

Weekly Diameter Growth

Figure 1, depicting the weekly diameter changes, reveals some of the peculiarities of tree growth within the growing season. The most striking feature is the large variation in the amount of growth that was recorded from week to week. Also of importance is the general tendency for all four positions on each tree to react similarly to the growth potentialities for the week, i.e., when growth at one position either increased or decreased from that of the previous week, the main stem at the other three positions grew in a like manner. This condition existed within a tree regardless of the treatment and all treatments followed similar trends for any given week.

The maximum increase in diameter was 0.034 inches for one week, and this occurred at Position 1 on the Class 50 trees during the 1946 season. Negative measurements were recorded both years. It is believed that they are directly attributable to a decrease in the water content of the tree. This factor unavoidably is confounded with all the weekly measurements, so that the true growth for any given week is not known. Nevertheless, it is the opinion of the writers that the tree ring band gives an excellent record of the relative magnitude of weekly growth. This error is absent in the total increases for the growing season as measurements were made when the constant mean diameter was known before the beginning of growth (except in the spring of 1946) and when the constant mean diameter could be determined after the cessation of growth. If the formation of new cells is regarded as an essential feature of growth then it is probable that growth actually is occurring even when the weekly measurement is negative. During periods of drought in the summer, the water content of the trunk might be reduced so much that a decrease in diameter would be recorded on the tree ring band, although cell formation and enlargement might actually be occurring in the cambial region. Wilson (*12*) and others have reported instances where plant stems show temporary decrease in total length though the growing regions appear to be elongating.

It is apparent in Figure 1 that growth starts slowly in the spring but increases rapidly, then slows down very gradually. Climatic conditions affect the growth rate. As Douglass (*5*) and many others have observed in tree ring studies, the frequent changes in meteorological conditions over the growing season probably largely control the weekly variations in growth as well as the seasonal trends.

Byram and Doolittle (*3*) con-

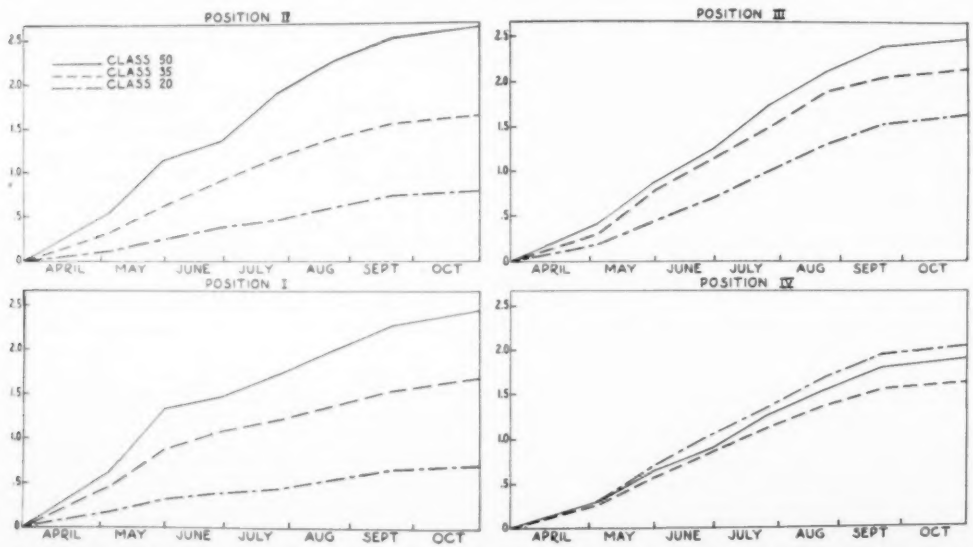

FIG. 3.—Increase in cross-sectional area in square inches during the 1947 growing season at each of the four positions, according to crown length class.

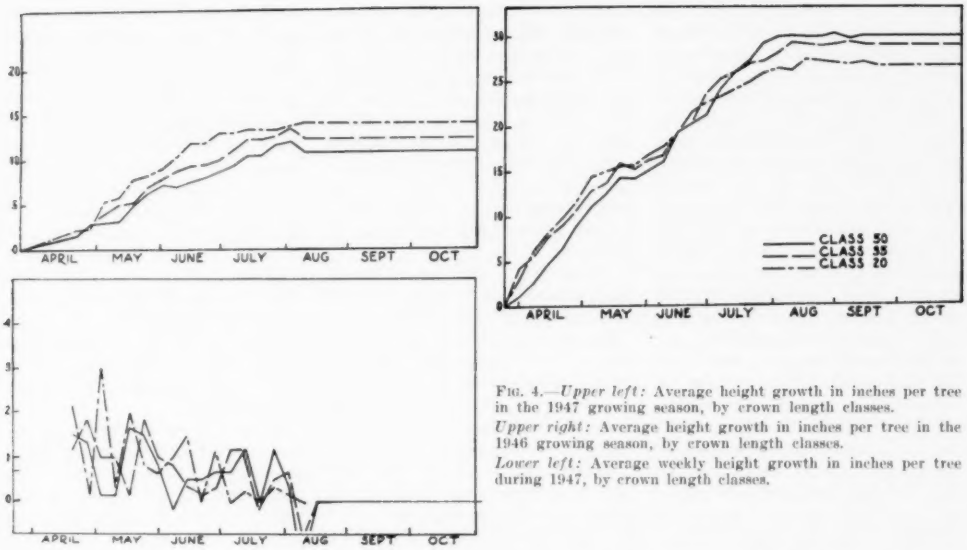

FIG. 4.—*Upper left:* Average height growth in inches per tree in the 1947 growing season, by crown length classes.
Upper right: Average height growth in inches per tree in the 1946 growing season, by crown length classes.
Lower left: Average weekly height growth in inches per tree during 1947, by crown length classes.

cluded that early in the season temperature and light were the chief environmental factors affecting diameter growth of *Pinus echinata*. Later in the season, when soil moisture began to be limiting, growth became increasingly dependent on rainfall. They also observe shrinkage during a drought.

There appears to be a distinctly different seasonal pattern for each position. Maximum rate of diameter growth at Position 1 occurred a few weeks after the resumption of growth, and the rate slowly decreased during the rest of the season. Maximum growth at Position 4 was reached a few weeks after the inception of growth, and this rate was maintained for about three months, then it slowly decreased until the end of the season. The patterns at Positions 2 and 3 are more or less intermediate between Positions 1 and 4 which represent the extremes.

Amos, Bissett, and Dadswell (*1*) reported that the maximum rate of diameter growth in *Eucalyptus gigantea* was attained near the ground considerably before it was attained at half height. They also observed that diameter growth started three or four weeks earlier in the upper part than in the lower part of the trunk of Eucalyptus, but no marked difference was observed in loblolly pine. Priestly and Scott (*10*) claim that in diffuse-porous trees resumption of cambial activity starts in the twigs and progresses slowly down the trunk, resulting in a considerable delay between the resumption of growth in the upper and lower part of the trunk. In ring-porous trees, in contrast, growth seems to be resumed rapidly and simultaneously from top to bottom of the trunk. Resumption of growth in loblolly pine seems to resemble that of ring-porous rather than diffuse-porous trees. Avery, Burkholder, and Creighton (*2*) consider it highly probable that a growth hormone produced in the terminal buds moves down the stem, stimulating cambial activity. Readers are referred to their paper for a resumé of the earlier literature dealing with relations between cambial activity and shoot growth.

Accumulative Diameter Growth

In Figure 2 the weekly increases in diameter for 1947 are plotted accumulatively over time for the entire season. Differences in growth rates between the two lower positions are apparent almost from the start of the season and become more pronounced as the season progresses. At Position 4 there was little difference in the growth rate between treatments for the first several months, but after that the Class 35 trees grew at a slower rate for the remainder of the season. At Position 3 there was very little difference in the growth rates of the Class 50 and Class 35 trees, but the Class 20 trees grew considerably less than the other two almost from the beginning.

These graphs indicate that increase in diameter at any given place on the lower part of the bole is primarily a function of the size of the crown above that place, presumably because growth depends on the photosynthetic potential of the crown. At Position 4 the total growth for the season is virtually the same for Class 20 and Class 50 pruning treatments, although it is well up in the crown in the Class 50 trees and under the crown in Class 20. The lesser growth of Class 35 trees at Position 4 is an exception not easily explained. Position 3 is in the crown, just under the crown, or well below the crown, depending on the treatment. Growth at Position 3 is similar for the Class 35 and Class 50 trees, but the Class 20 trees grew considerably less at that place. The two lower positions are under the crown

in all three treatments, and from the graphs it can be seen that diameter growth at these positions is related to the distance below the crown and the size of the crown.

These data substantiate the observation of foresters that tree trunks tend to grow like a cylinder below the crown and like a cone within the crown. Growth in trunk diameter decreased from the base of the crown downward to breast height regardless of the total amount of crown. Data were collected down to breast height level only, hence these generalities cannot be extended to the ground level for they would fail to consider increased growth near the ground level, commonly known as butt swell. In this study, the Class 20 trees increased in diameter only one-sixth as much at Position 1 as at Position 4, whereas growth at Position 1 on the Class 50 trees was nearly one-half of that at Position 4.

The Class 50 trees can be considered the control group, for virtually no live branches were removed from these trees in pruning. The effect of crown reduction in the Class 35 and Class 20 trees was to reduce diameter growth along the bole, and to alter the form of the trunk below the crown. Apparently the pruning treatments had little effect on the growth rate of the portion of the stem bearing the remaining crown.

Accumulative Increase in Cross Sectional Area

It is difficult to obtain a true picture of the increase in volume from the increase in diameter at various heights because a given increase in diameter of a small stem represents a smaller increase in cross-sectional area than the same increase in diameter of a larger stem. For example, an increase in diameter of 0.01 inch results in an increase of cross-sectional area of 0.03 square inch for a 2-inch stem and 0.09 square inch for a 6-inch stem. Both stems increase the same amount in diameter, but the cross-sectional area of the larger stem increases three times as much as that of the smaller one. In order to observe the effects of reduction of crown on volume growth, the diameter increases were converted to increases in cross-sectional area and the results are shown graphically in Figure 3. Since the increase in area multiplied by one equals the volume growth in cubic inches, the graphs also represent the volume increase of a section of the bole one inch in height at each point of measurement.

Differences in cross-sectional area growth, due to treatment and position, are as pronounced as differences in diameter growth, but the order of magnitude is not the same. Area growth at Position 4 was relatively similar for all three treatments in both seasons, but in the Class 50 and Class 35 trees it was the place where the least growth occurred, and in the Class 20 trees it was the place where the most growth occurred. In the Class 50 and Class 35 trees there was greater increase in area below the crown for both seasons than there was in the crown. Growth in area for all treatments and positions was consistently greater in 1947 than in 1946, as can be seen in Table 1.

Diameter growth for the Class 50 trees was greater within the crown than below the crown, but the reverse was true of area growth. Diameter growth within and just below the crown in the Class 35 trees was about the same, but there was more growth in area just below the crown. Growth in both diameter and cross-sectional area decreased from the crown to breast height in the Class 20 trees.

Height Growth

The weekly measurements for the 1947 season and the graphs of accumulated height growth for both seasons are presented in Figure 4. There is neither a consistent pattern of height growth that can be attributed to pruning treatments nor any consistent correlation between height and diameter growth in either a positive or negative direction for either year. From a seasonal viewpoint height growth started a few days before diameter growth, but height growth in both years ceased about August 1, or at least two months before diameter growth ceased. Kramer (*7*) measured height growth of 2- and 3-year-old loblolly pine, and Reed (*11*) measured 6-year-old trees. Height growth curves of the younger trees were similar to those of our older trees, except that growth ceased several weeks later in the younger trees.

The differences in height growth between treatments were not significant for either year. In 1946, the Class 50 trees grew the most and the Class 20 trees the least, but in 1947 this was reversed. Average height growth in 1946 for all treatments was about 28 inches, and in 1947 it was about 13 inches. The average height of all the experimental trees, prior to the experiment, was about 35 feet or an average yearly growth of 30 inches. Average height growth in 1946 was slightly below this average, but in 1947 it dropped to less than half of this average.

The depth of the A horizon and the imbibitional water value of the B horizon were measured to determine the site index of the experimental area by Coile's (*4*) equation. The site index as calculated was 67, i.e., the height of the average dominant tree should be 67 feet at 50 years of age. In the first 14 years the trees grew a total of 35 feet, and from the site index it is estimated that they will grow 32 feet in the next 36 years. This is an average of slightly less than a foot a year, which is of the general magnitude of the height growth of the 1947 season.

TABLE 1.—GROWTH IN CROSS SECTION AREA IN SQUARE INCHES BY POSITION AND CROWN LENGTH CLASS

	1946			1947		
	Class			Class		
Position	50	35	20	50	35	20
1	12.81	8.09	2.49	14.75	10.14	4.23
2	12.73	7.59	2.72	15.74	9.82	4.66
3	11.74	8.25	4.08	14.90	12.86	9.84
4	6.99	6.50	6.66	11.40	9.76	12.24

Climatic and Soils Data

Measurements of rainfall, evaporation, and soil moisture were made for most of the 1946 growing season, and for the entire 1947 season. There was a negative correlation between rainfall and evaporation, as would be expected. No correlation was found between rainfall or evaporation and height growth. Diameter growth appeared to be correlated with rainfall and evaporation for specific weeks, but this did not hold over the entire season. Failure to find a close correlation between these factors over the entire season is not surprising, because only extremely high rates of evaporation and transpiration would be expected to affect growth. Rainfall would be expected to affect growth only if soil moisture was limiting; hence some rains might have no effect on the rate of growth.

Moisture content of the A_1 horizon was closely related to current rainfall, and this was true to a lesser extent of the A_2 horizon. In 1946, for which there are incomplete data, the moisture content of the B_1 horizon seemed to decrease as the growing season progressed and to rise toward the end of the season. This trend was not as sharply defined in 1947. There was no apparent correlation between weekly growth in height or diameter and the current moisture content of the soil at any horizon examined. Soil moisture was available during both growing seasons, since the field measurements show that the wilting point was not reached during either season. The negative diameter growth observed for certain periods suggests, however, that internal moisture deficits developed at times when the soil yet contained some readily available water.

Summary

Eighteen 14-year-old loblolly pine trees about 35 feet tall and 6 inches in diameter at breast height were selected for uniformity and divided into six blocks, each containing three trees as uniform in size and shape as possible. The three trees in each block were pruned so the amount of crown left occupied 50 percent, 35 percent, and 20 percent of their total height. Weekly measurements were made of height growth and of diameter growth at four positions on the trunk, for the growing seasons of 1946 and 1947. These positions were breast height, 50 percent, 65 percent, and 80 percent of total height. Rainfall, evaporation, and soil moisture were also measured. The following conclusions were drawn from an analysis of the data.

1. Weekly variations in rate of diameter growth were similar at all four positions on the trunk, but the seasonal trend varied at the different positions. Maximum rate of growth was attained early in the season at all positions, but it soon decreased near the base, although it continued at the same rate during most of the season near the top of the trunk. Increase in diameter began and ceased at approximately the same time at all four positions on the tree trunks.

2. The size of crown had a marked effect on the amount of diameter growth below the crown, but relatively little effect on growth within the crown. Trees with 50-percent crowns grew most, and those with 20-percent crowns grew least in diameter at all but the uppermost position, where they made almost the same amount of growth. Diameter growth decreased with increase in distance below the crown with all sizes of crown, the reduction increasing as the size of the crown was decreased by pruning. Trees with 20-percent crowns increased only one-sixth as much in diameter near the base as near the top, but the increase in diameter of trees with 50-percent crowns was nearly half as large near the base as near the top of the trunk.

3. Increase in cross-sectional area of the trunk was similar near the top for all sizes of crown, but it decreased with distance below the crown in trees with small crowns, and showed little change in trees with large crowns. The distribution of growth on tree trunks tends to make their shape cylindrical below the crown and conical within the crown. This tendency is more pronounced in trees with small crowns than in those with large crowns.

4. Height growth, for the range of crowns studied, was not affected by the reduction in size of crown.

5. Height growth started a few days before measurable diameter growth occurred in the spring, but it ceased about the first of August, while diameter growth continued until about the first of October.

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The Cloquet Red Pine Thinning Plots[1]

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Twenty years have passed since four tenth-acre thinning plots were established in a dense stand of 15-year-old red pine (Pinus resinosa) *at the Cloquet Experimental Forest, Cloquet, Minn. This progress report summarizes the results obtained thus far. It is the fifth in a series of articles appearing in the Journal (3, 4, 5, 6).*

THE VIRGIN RED PINE on this area was cut during the heavy seed year of 1909 just as the Cloquet Experimental Forest was being established. Cutting was supervised by the Indian Service and all slash was piled and burned as logging progressed. The volume of the original stand was about 15,000 board feet per acre and the age about 100 years. The area where the thinning plots are located was cut over in the fall just as the cones were opening. The position of the undercuts on old stumps indicates that the dense areas of reproduction occur where the tops of several trees overlapped. This accounts in part for the great variation in density of the young stand.

At the time of thinning in 1927, the stand was 15 years old and heavily overstocked. The total number of trees per acre ranged from 13,140 to 20,780 on the tenth-acre plots and the average height from 3.5 to 4.4 feet (Table 1). In marking for thinning, an attempt was made to obtain spacings of 4, 6, 7, and 9 feet square in the various plots. The plots are named in accordance with these aims. Figure 1 shows the 6 by 6 plot one year after thinning. The plots have since been left unthinned in order to determine when the growth rate declines and how much volume is lost by not thinning for the various spacings. An unthinned control plot was established in 1937.

Measurements

The 5-year measurements of the plots are summarized in Table 2. The left-hand columns record the actual measurements made from 1927 through 1947. The right-hand columns record the differences between each two adjacent measurements. They thus show in detail the periodic changes in the plots. For basal area, average diameter, and average height, these changes may be termed the *net growth* of these values. It should be borne in mind, however, that these net growth figures apply to the entire plot and not to the individual trees. For example, the net increase in average diameter of the plot will be greater than that of the individual trees because the death of small trees during the period will increase the average diameter of the plot even if no growth takes place. Again the current average height growth of the dominant trees may not differ significantly between the plots. That the average height growth for the 4 by 4 plot is smaller than that for the 9 by 9 plot, may well be due only to the larger proportion of intermediate and suppressed trees in former plot.

The plot statistics for the check plot differ from those previously published because of a correction of plot area that does not affect conclusions previously drawn.

TABLE 1.—TREATMENT DATA 1927
(PER ACRE BASIS)

Desired spacing	Total no. of trees: Before thinning	Removed	After thinning	No. with d.b.h. 1 in. and over	Average height: Before thinning	After thinning
Feet						*Feet*
4 by 4	20,780	18,140	2,640	260	3.8	6.0
6 by 6	15,020	13,490	1,530	700	4.1	7.7
7 by 7	13,140	12,260	880	140	4.4	6.8
9 by 9	20,180	19,610	570	60	3.5	5.7

TABLE 2.—PLOT STATISTICS (PER ACRE BASIS) AFTER THINNING

Plot	Year of measurement: 1927	1932	1937	1942	1947	Periodic development: 1927-32	1932-37	1937-42	1942-47
				Total number of trees					
Check			4820	4240	3420			−580	−820
4 by 4	2640	2610	2510	2510	2410	−30	−100	0	−100
6 by 6	1530	1510	1500	1500	1490	−20	− 10	0	− 10
7 by 7	880	840	840	830	830	−40	− 10	0	0
9 by 9	570	530	500	500	500	−40	− 30	0	0
				No. with d.b.h. 1 inch and over					
Check			4,060	3,840	3,400			−220	−440
4 by 4	260	2,250	2,460	2,460	2,410	1,990	210	0	− 50
6 by 6	710	1,500	1,500	1,500	1,450	790	0	0	− 50
7 by 7	140	810	830	830	830	670	20	0	0
9 by 9	60	430	500	500	500	370	70	0	0
				Basal area (*Square feet*)					
Check			97.3	126.9	158.6			29.6	31.7
4 by 4	2.5	38.6	87.9	135.0	175.5	36.1	49.3	47.1	40.5
6 by 6	6.0	39.1	85.2	137.4	178.3	33.1	46.1	52.2	40.9
7 by 7	1.6	19.6	50.5	92.1	139.5	18.0	30.9	41.6	47.4
9 by 9	0.5	6.3	19.7	47.3	86.4	5.8	13.4	27.6	39.1
				Average d.b.h. (*Inches*)					
Check			2.05	2.46	2.92			0.41	0.46
4 by 4	1.33	1.77	2.55	3.11	3.63	0.44	0.78	0.56	0.52
6 by 6	1.25	2.27	3.21	4.10	4.73	1.02	0.94	0.89	0.58
7 by 7	1.42	2.11	3.33	4.48	5.52	0.69	1.22	1.15	1.04
9 by 9	1.27	1.63	2.69	4.18	5.63	0.36	1.06	1.49	1.45
				Average height (*Feet*)					
Check		10.4	14.6	18.1	24.1		4.2	3.5	6.0
4 by 4	6.0	11.2	16.3	20.9	28.0	5.2	5.1	4.6	7.1
6 by 6	7.7	12.5	19.3	25.8	33.2	4.8	6.8	6.5	7.4
7 by 7	6.8	11.0	16.8	23.5	31.2	4.2	5.8	6.7	7.7
9 by 9	5.7	8.5	12.8	19.7	27.7	2.8	4.3	6.9	8.0

[1]Published as Scientific Journal Series Paper no. 2668 of the Minnesota Agricultural Experiment Station.

FIG. 1.—View of the 6 by 6 plot one year after thinning.

Volumes were computed for the first time in 1947 (Table 3). The present appearance (1949) of the 8 by 8 plot is shown in Figure 2.

Results

Losses during the 20 years since thinning have increased the spacing of all of the plots. Present spacings are 3.4 feet square for the check plot, and 4.2, 5.5, 7.3, and 9.3 feet square for the thinned plots. During the 1942-47 period, the check plot continued to lose trees totalling 820 trees per acre. Mortality was 100 trees per acre in the 4 by 4 plot, but only 10 in the 6 by 6 plot, and none in the wider spacing plots. Continued mortality should occur in the check plot and the 4 by 4 plot during the next period.

The diameter growth was less during the 1942-47 period than the previous period for all plots except the check plot. The apparent increases in diameter of the check trees is caused largely by the loss of a large number of small trees. The same relationship that previously existed between the density of the stand and diameter growth continues to be apparent. The smaller growth rate during 1942-47 is probably the result of poorer growing seasons which affected all plots, although the effect was less on the 7 by 7 and 9 by 9 plots. The average height of the dominants is greatest for the 6 by 6 spacing (Table 3).

Table 2 gives height growth data for the 20 years since establishment. All heights were measured by placing an extendible scale beside each tree. In the next remeasurement in 1952 a hypsometer will have to be used. Height growth was very uniform for the 6 by 6 and wider spacings during the 1942-47 period. The slower rate of growth in the check plot may indicate that some stagnation is taking place.

Volumes were not computed prior to 1947 because of the small diameters of the trees at earlier times. Over the 35-year history of the stand, the net growth has been best on the plot thinned to a 6 by 6 spacing at the age of 15. This applies to merchantable volume as well as total volume of trees 1 inch and over in diameter.

TABLE 3.—1947 VOLUME AND GROWTH

	1947 Volume per acre				Mean annual growth			Ave. height
	Total	Merchantable			Total	Merchantable		Dominants
	Cu. ft.	*Cu. ft.*	*Percent*	*Cords*	*Cu. ft.*	*Cu. ft.*	*Cords*	*Ft.*
Check	1,993	718	36	9.0	57	21	0.26	
4 by 4	2,294	1,180	51	13.1	66	34	.37	32.7
6 by 6	2,587	1,976	76	22.0	74	57	.63	35.5
7 by 7	1,897	1,519	80	16.9	54	43	.48	33.4
9 by 9	1,029	820	80	9.2	29	23	.26	31.1

Discussion

The Cloquet red pine thinning plots may advantageously be compared with the most applicable yield table for the species, with a similar series of plots in the Chippewa National Forest, and with thinning standards based upon total height.

Comparing the number of trees on the Cloquet plots with the normal yield table published in Eyre and Zehngraff (*1*), we find that the 9 by 9 plot now has approximately the normal number of trees for a 48-year-old stand, the 7 by 7 plot for a 35-year-old stand, the 6 by 6 for a 20-year-old stand, and the 4 by 4 plot more than the number for a 20-year-old stand.

Basal areas for the 4 by 4 and 6 by 6 plots are now approximately normal for a 35-year-old stand. If the present rate of growth continues all the thinned plots should have normal basal areas at the next remeasurement in 1952.

The normal yield table gives a merchantable volume of 1,175 cubic feet from trees 5 inches and larger for 35-year-old red pine with an additional 6 cords in small trees and tops. The table indicates how closely the 6 by 6 plot approaches

FIG. 2.—The 6 by 6 plot 22 years after thinning.

normality with a merchantable volume of 1,976 cubic feet for all trees.

A similar series of red pine plots, thinned to spacings of 3.6, 5.9, 7.8, and 9.9 feet, have been reported by Eyre and Zehngraff (2), from the Chippewa National Forest. The initial stand on the Chippewa plots was not so dense, varying from 2,800 to 5,600 trees per acre at 23 years, compared to 13,140 to 20,780 trees for the Cloquet plots at 15 years. The average height of the dominants in the Chippewa plots varied from 20 to 23 feet in 1927, but on the Cloquet plots they varied from 5.7 to 7.7 feet. It should be noted that the average height for the Cloquet plots are based on all trees left after thinning. However, these were nearly all dominant trees in so far as it is possible to classify them at such an early age. This would indicate that the Cloquet plots were in a stagnant condition because of overstocking. Ten years after thinning the height of the Cloquet stands were still below those on the Chippewa at 23 years. The mean annual height growth for the 20 years after thinning varied from 0.9 to 1.27 feet for the Cloquet plots and on the Chippewa plots from 0.8 to 0.9 feet. The heights on the Cloquet plots may eventually catch up with the heights on the Chippewa plots.

Twenty years after thinning the total peeled volume of the Cloquet plots varied from 1,028 to 2,587 cubic feet per acre, and the Chippewa plots from 1,247 to 2,379 cubic feet per acre. This apparently greater volume on the Cloquet plots may be the result of less mortality and to better sites than on the Chippewa plots. The cord volume on the Chippewa plots varied from 16 to 24 cords per acre while the Cloquet plots varied from 9 to 22 cords per acre. The mean annual growth gives a better comparison since the Chippewa plots are older. On the Chippewa plots the mean annual growth per acre varied from 0.38 cord with the 9.9 spacing to 0.56 for the 3.6 spacing, while on the Cloquet plots it varied from 0.26 cord on the check plot with 3.4 spacing to 0.63 cord with the 5.9 spacing. This comparison indicates that the Cloquet plots are probably just approaching a period of rapid growth.

Wilson (8) has suggested the use of a numerical expression of stocking in terms of height as an aid to thinning practice. He has suggested that red pine be thinned to a spacing of one-fifth to one-sixth the height of the average dominant tree. Applying his index to the Cloquet plots the percentages in Table 4 are obtained.

TABLE 4.—SPACING AS A PERCENTAGE OF AVERAGE DOMINANT HEIGHT

Plot	1927	1947
4 by 4	66	12.8
6 by 6	59	15.5
7 by 7	108	21.9
9 by 9	163	29.9

The 1927 thinning was, of course, made in a dense young stand with very little height growth, in all probability too young for Wilson's height-spacing index to be valid. The percentages for 1947 indicate that the 4 by 4 and 6 by 6 plots could be thinned to maintain this 20 percent index.

If we accept the 20 percent index as valid for red pine stands of this age, 1,380 trees per acre may be thinned from 4- by 4-foot plot and 620 trees per acre from the 6- by 6-foot plot.

In 1946 Basil Wales (7), commenting on the 1942 report for these plots, suggested that continued thinnings be made at 10-year intervals and compiled a theoretical yield table for the 6- by 6-foot plot. Beginning at 30 years he suggested the removal of 600 trees yielding 3 cords of conversion wood, 250 trees at 40 years yielding 5 cords of pulpwood, 230 trees at 50 years yielding 4,000 board feet of box bolts and 5 cords of pulpwood, 200 trees at 60 years yielding 8,000 board feet and 5 cords of pulpwood. The grand total yield at 80 years would be 28 cords and 43,000 board feet. Using Wilson's index as a guide it should be possible to remove 600 trees from this plot at 35 years. The yields shown in Table 3 indicate that it should be possible to cut the suggested volume but that Wales' time table may have been off 5 years.

The results of this study indicate that red pine stands on an average site in Minnesota can carry a density of 1,500 trees per acre up to 35 years without danger of stagnation. At that time a commercial thinning should be possible. If the density is as high as 2,400 trees per acre a volume loss through stagnation is apparent at 35 years. If the density is 500 to 800 trees per acre there is a volume loss in the early years since probably the trees are not able to utilize the entire productive capacity of the site.

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Dissolving Pulp From Southern Hardwoods[1]

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WOOD PULP destined for conversion into men's suits, women's dresses, carpets, rugs, drapes, hosiery, seat covers, automobile tires, etc., is known as dissolving pulp. This raw material represents less than 5 percent of our total wood pulp production. However, it has been most essential in the processes transforming the wood carbohydrates or cellulose into rayon, cellophane, nitro-cellulose explosives, plastics, and an endless list of other specialized items.

Cellulose was first isolated from wood on a commercial basis in the United States about 1885 by the application of caustic soda. This was known as the soda process or the soda pulp method. Approximately 15 years later the groundwood mill came into existence. The pulp made by this method is known as mechanical wood pulp and is the basis of all newsprint. The third wood pulping method, known as the sulphite process, was introduced in the United States about 1900. In this process the cellulose is separated from the wood lignin with an acid solution of calcium bisulphite. By continually refining and developing this sulphite process, bleached and dissolving grades of wood pulp were manufactured. It was in 1910 that the fourth wood pulping method came into domestic use: the sulphate process. In this method the cellulose is isolated by using a strongly alkaline solution of caustic soda and sodium sulphide. The sulphate process blazed the trail for the pulp industries into the great pine and hardwood forests of the South which since have played the important role in the production of Kraft paper and which hereafter will play a major part in the manufacture of dissolving wood pulp.

The increasing need for rayon became apparent when it was found to be the best fiber for tire cord. In 1939 only 9 million pounds of rayon went into tires, but by 10 years later, 1949, that figure had jumped to 282 million pounds. It is estimated that by 1953 more than 80 percent of all tire cord will be made from viscose rayon.

Prior to 1950 all commercial wood pulp of dissolving grades was manufactured by the sulphite process. At this time International Paper Company's new rayon pulp mill at Natchez, Miss., began producing dissolving pulp from southern hardwoods by the sulphate process. This is the first and only mill in existence that has employed the sulphate process in producing a wood dissolving pulp. The Natchez mill, since its opening in 1950, has been turning out viscose rayon pulp principally from gum wood at the rate of 100,000 tons a year.

Although hardwoods have short fibers and, therefore, do not make strong paper, the short fibers of hardwood are suitable for viscose or dissolving pulp.

The new use of hardwood makes possible a more balanced cutting in the southern woodlands. The heavy cutting of pine for many years has been changing the second-growth stands of the South into a predominance of hardwoods which had little or no value. Now, with the increased use of hardwood the forester and land manager can maintain a greater percentage of the more valuable pine in the stands. It makes possible the practice of more intensive forestry, just as new opportunities of forest practice were possible when pulpwood markets were opened up in the Southeast and began using worked-out turpentine trees that had no value in the stand.

From a forester's standpoint, engaged in marking bottom land hardwood stands and confined to removing only the gum at this time, the immediate effects of such thinning in these stands is only visual. With the passing of years to enable us to check increased growth and other hoped-for benefits, these pulpwood thinnings have only "straightened up" the stand of timber.

By the development of the new sulphate process in the manufacture of viscose pulp from hardwoods a new field for the growth of forest products industry has been established in the South, providing new income for southern workers and farmers and also providing a market for formerly non-commercial hardwoods. It has increased the incentive for the practice of effective forest management.

The market and demand for dissolving pulp is so broad and so great that future possibilities are unlimited as the following quotation from a recent publication from International Nickel Company, so well demonstrates:

"A man can rise in the morning and apply brushes with nitro-cellulose handles to his teeth and hair, eat a sausage breakfast complete with viscose casing and ride into the country in a car finished with cellulose lacquers and plastic seat covers. If he is impressed by the beautiful country side as he views it through clear safety glass made with cellulose derivatives, he may stop and take a few pictures on cellulose acetate film, and if tragedy now intervenes and a hunter mistakes him for a browsing moose and shoots him with a bullet propelled by nitro-cellulose powders—the victim can inform his wife that she is a widow by writing a note on paper that is nearly pure cellulose and she will mourn him in a new rayon dress of the regenerated molecule."

[1]Paper presented at a meeting of the Division of Forest Products, Society of American Foresters, Biloxi, Miss., December 14, 1951.

Notes

Estimating the Time Needed for Girdling Hardwoods

To determine the cost of girdling unwanted hardwoods on an operational basis, a time study was made in 1951 on the Flat Top Experimental Forest near Birmingham, Ala. Following a commercial stand improvement cut, cull hardwoods were girdled on a group of eight compartments ranging from 16 to 31 acres in size and totaling 184 acres.

A slightly less accurate but even simpler prediction could have been made merely by multiplying sum D by .005 man-hour.

Data needed to apply the formula to other hardwood stands may be obtained from a sample cruise in which trees to be girdled are tallied by diameter class. Where woods labor works faster or slower than in this study, the constants .006005 and —.010066, or .005, should be changed to those appropriate to the local crews. However, in two quite dissimilar operations in southern Arkansas, the required times differed less than 5 percent from those estimated by using the Alabama constants.

TABLE 1.—STAND DATA AND TIME REQUIREMENTS FOR GIRDLING UNDESIRABLE HARDWOODS IN NORTHERN ALABAMA

Class of hardwoods to be girdled	Area sampled	Average d.b.h. girdled	Trees girdled per acre	Sum of girdled d.b.h.'s per acre	Actual girdling time	Estimated girdling time
	Acres	*Inches*	*Number*	*Inches*	*Man-hours per acre*	
Culls over 9½ inches d.b.h.	58	15.6	2.5	38.9	0.21	0.21
Culls over 5½ inches d.b.h.	126	8.7	12.3	107.0	.51	.52
All over 3½ inches d.b.h.	184	6.4	111.9	718.8	....	3.19

Two intensities of girdling were applied. In one, all culls over 9½ inches d.b.h. were girdled; in the other, all culls over 5½ inches. For each compartment, a record was made of the total time required for girdling and of the number and size of the trees so treated (Table 1). In addition, a tally was made of all hardwoods over 3½ inches in diameter, so that the time required for girdling this group of trees might be estimated.

The study indicated that girdling time was related to the number of trees treated and the sum of their diameters. By regression analysis, a formula was derived that predicted time in man-hours per acre from N (number of trees girdled per acre) and sum D (the sum of d.b.h.'s girdled per acre, in inches).

The formula, which can be applied to other hardwood stands where crews of similar efficiency may work, is:

Man-hours=.006005 (sum D)—.010066(N).

As Table 1 shows, the time estimated by the formula agrees closely with the time actually required.

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Forestry Activities in Yugoslavia

Foresters in Yugoslavia are showing renewed activity in research related to silviculture and forest management. This is evident in the number and scope of papers appearing in successive issues of two technical journals, which recently arrived from this Balkan country.

The Society of Foresters in Serbia (7/1 Kn. Miloša, Beograd, Yugoslavia) publishes a bi-monthly journal entitled, "Šumarstvo" (*Forestry*). The University College of Forestry in Beograd publishes the results of forestry research on an annual basis.

The Institute of Biological Forestry Research in Sarajevo (Bosna) collects the works of their members in its annual reports (edited by Godišniak). Forestry papers ("Šumarski List") published in Zagreb give current news about the work of professional forestry circles in Croatia. In Ljubliana (Slovenia) the professional paper *Forest* is mostly concerned with questions of forest industry.

From these one gets the impression all parts of the Republic of Yugoslavia are joining in a common effort to develop and popularize forestry knowledge. In addition, there is evident a wish to make contacts with professional circles and forestry research workers in the United States. The library of the University of Wisconsin, probably among others, has received all six numbers of the Journal of the Society of Foresters in Serbia, the bi-monthly "Šumarstvo" for 1951; and the 1951 bulletin 2 of the University College of Forestry in Beograd.

In the *Forestry* of the Serbian society special emphasis is given to an article of Eng. Djordje Vovič: "The Character and Tasks of the Basic Long-range Plan of Reestablishment of Forests." It is evident that all forest policy is carried out by the state (federal government). The author is enthusiastic about the possibilities in Yugoslavia to develop a basic plan for the reestablishment of public forests. Americans who have read the story of Metasequoia would find of interest the article of Eng. S. Kolarovič on his research work with *Picea Omorica* in Serbia. This spruce is known as a botanic relic from the Tertiary era. It is growing now only in a few areas in the mountains of Yugoslavia. Fourteen places where it is found have been proclaimed as reservations or national monuments.

The Bulletin of the University College in Beograd for 1951 includes articles by Dr. B. Šolaja on the physical and chemical properties of turpentine of *Pinus Nigra*

and *P. Silvestris*. Eng. Mirković describes an instrument for direct measurements of horizontal distances in a mountain region.

Despite difficult economic conditions which exist in Yugoslavia, current achievements in the field of forestry research in that young republic compare favorably with work elsewhere in Europe. This reviewer feels that distinct good may be done if professional people and forestry scientists in this country will show their interest by exchanging ideas and literature with their forestry colleagues in Yugoslavia.

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Cost of Pruning Red Spruce in Natural Stands

The value of and justification for pruning species not now commanding high prices for quality grades of logs have often been questioned. Red spruce is such a species. It makes good lumber with a high strength-weight ratio, and is highly regarded for a number of uses. However, up to now red spruce logs have not been sold by grade in the spruce-fir region of northern New England. Whether this situation will persist for very many years is open to debate. It seems quite possible that with the growing scarcity of quality lumber, the demand for prime logs in 20 years will be such that clear spruce will bring a premium price.

Since pruning is a common method for improving the ultimate quality of lumber sawed from a tree, it would be desirable to have some data on costs of pruning red spruce in natural stands. Then one of the principal financial elements in an investment in growing quality logs for the future could be evaluated.

A time study of the cost of pruning red spruce in natural stands was undertaken on the Penobscot Experimental Forest near Bangor, Maine in the spring of 1951. The work was carried out as a joint cooperative project by the Northeastern Forest Experiment Station and the Forestry Department of the University of Maine. The trees selected occurred in a typical uneven-aged spruce-fir flat type where there was a mixture of hemlock, paper birch, red maple, and some white pine with the spruce and fir.

One hundred and thirty spruce were pruned, ranging in size from 3 to 8 inches d.b.h., and averaging 6.1 inches. Forty-five percent of the trees were co-dominant with respect to crown class, 45 percent were intermediate, and the rest were dominant. Only vigorous trees with good crowns were selected. Total heights averaged about 40 feet.

Hand pruning saws were used to prune branches to a height that could be conveniently reached, and 14-foot pole saws were used from that point up to 18 feet. No ladders were used. Ninety percent of the trees were pruned to 18 feet, the remaining to heights of 10, 12, or 14 feet. By far the greater proportion (more than 92 percent) of the branches removed were dead. The mean diameter of the pruned branches was 0.56 inch. An average of 80 branches per tree were pruned. Pruning was done by two students in the Forestry Department of the University of Maine.

Separate records were made to the nearest 15 seconds, of the time required to prune, and to walk to the next tree. The "walking" time includes time for selecting desirable spruce crop trees as well as for walking from one tree to the next. The significant results of this study may be summarized as follows:

	Minutes	Seconds
Average pruning time per tree	6	17
Average walking time per tree	2	35
Total time per tree	8	52
Pruning time as affected by number of branches:		
Fewer than 60	4	43
60 to 99	5	51
100 or more	8	39
Pruning time as affected by average branch size:		
Small (¼ in.)	4	8
Medium (½ in.)	6	3
Large (¾ in.)	8	2

Pruning time for individual trees ranged from 2 to 16 minutes. Half the trees took between 5 and 7 minutes to prune, and 70 percent fell between 4 and 8 minutes. Only 15 percent of the trees took less than 3 or more than 10 minutes.

It is readily apparent that pruning trees with more than 100 branches (in 18 feet of trunk) can be a relatively costly operation. When pruning time was plotted over number of branches per tree an almost straight line relationship resulted for up to 90 branches, but beyond this point the curve climbed steeply. The time required to prune 120 and 130 branches per tree was 10 and 12 minutes, respectively. This increase of 2 minutes for 10 branches contrasts sharply with only 0.3 minutes for 10 branches when there are between 30 and 40 per tree. This considerably greater expenditure of time is the result of a fatigue factor, plus the fact that with branches growing closer together on the trunk more time is taken up by maneuvering the saw blade to assure a cut close to the bole.

As was to be expected, however, the average size of pruned branches also exerted a considerable influence upon the time of pruning. To evaluate this effect each tree was classified as to average size of branch: small, medium, and large. Average branch diameters corresponding to these size classes were approximately ¼ inch, ½ inch, and ¾ inch respectively. It will be noted that trees with large branches required over 70 percent more time to prune than those with small branches.

The combined effect of number and size of branches was examined to the extent permitted by the data. Thus, pruning time for trees with 100 or more branches was 5 minutes 54 seconds for small branches,

but 11 minutes 20 seconds for large branches. Similarly, while the average time for all trees having between 60 and 100 pruned branches was 5 minutes 51 seconds, the average was 7 minutes 25 seconds for trees having large branches, but only 3 minutes 49 seconds for those having small branches.

For the purpose of comparison a similar record was made of the time required to prune 50 white pine trees in the same area at the same time. The pine averaged about 1 inch larger in d.b.h. but were similar to the spruce in height and crown class. The contrast between the species was rather striking. Average pruning time for pine was only 2 minutes 42 seconds as compared to 6 minutes 17 seconds for spruce. This is accounted for in part by the difference in number of branches pruned per tree: 44 for pine, 80 for spruce. The proportional difference is greater for time than for number of branches, and since there was no appreciable difference in average branch size it may be concluded that pine branches were more easily sawed than spruce.

At an hourly wage of $1.00 the total expended time for pruning red spruce, including walking time, of 8 minutes 52 seconds represents a cost of 14.8 cents per tree. Thus, the cost of pruning 100 trees per acre would be $14.80. The cost for white pine, on the other hand, would be $8.80. These calculations are based on actual heights pruned in this experiment, which in 90 percent of the cases were 18 feet. The average pruned height for all spruce trees was 17.8 feet.

The woodlot owner considering pruning may not wish to prune every tree for the first log length, at least not in one operation. It would be useful, perhaps, if he were able to estimate the cost for each tree on the basis of the probable time per lineal foot of pruned stem. Costs of pruning red spruce — excluding walking time — have been recomputed on this basis and are presented in the following tabulation. The effect of branch size has not been considered. All figures shown are on a per-lineal-foot basis.

Branches to be pruned	Pruning time	Cost of pruning at $1 per hour
Number	*Seconds*	*Cents*
2	14	0.39
3	16	.44
4	18	.50
5	22	.61
6	27	.75
7	37	1.03

Under conditions similar to those encountered in this study a forest owner can make a fairly reliable estimate of the cost of pruning red spruce trees. He can quickly estimate the average number of branches per lineal foot of trunk that will have to be pruned, and using the costs presented here he can easily figure the cost per tree. He may wish to reject as unprofitable to prune any tree having more than 5 branches per foot. With a little experience he can also gage the average diameter of branches and perhaps dismiss from consideration trees with branches averaging more than ½ inch. To the cost of actual pruning must also be added about 5 cents per tree to cover walking and "looking" time. Knowing the probable average cost per tree the investment per acre—either dollars or man-hours—can readily be calculated.

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Harry T. Kendall Dies, Lumber Industry Leader

Harry T. Kendall, 69, prominent lumber industry leader suffered a heart attack on April 25 and died on May 2. Death occurred at White Sulphur Springs, W. Va., where he had been attending a conference of the joint Canada-United States Committee of the Chambers of Commerce of the two countries.

Mr. Kendall was born on May 26, 1882 at Clay Center, Kansas. He launched his career in the lumber business early in the 1900's as a lumber salesman in the South. From 1913-1926, he became general sales manager of the Kirby Lumber Company of Houston, Tex. From 1926 to 1932, he was assistant general manager and general sales manager of the Central Coal and Coke Company of Kansas City, Mo. From 1934-1950, he was general manager and director of the Weyerhaeuser Sales Company, St. Paul, Minn., and was chairman of the board of directors of that company from 1950 to 1952.

At the time of his death, Mr. Kendall was prominent in many businesses and government activities related to the lumber industry. He was president and director of the Globe Box Company of Houston, Tex.; director, Allied Building Credit, Los Angeles, Calif.; consultant to the Munitions Board, Washington, D. C.; chairman, Lumber Manufacturing Industries National Advisory Committee of the Department of Commerce (NPA). He was appointed a director of the Chamber of Commerce of the U. S. on May 2, 1951 and served in that capacity as well as being a member of its Natural Resources Committee and of its governing board for *Nation's Business* until his death.

He had been scheduled to retire July, 1, 1952 from his position as chairman of the board of the Weyerhaeuser Sales Company. For the past nine months, he had given generously of his time in managing the National Lumber Manufacturers Association, Washington, D. C. following the resignation of R. A. Colgan, Jr., its former executive vice president.

Reviews

Modern Gardening.
By P. P. Pirone. 371 pp. Simon and Shuster, New York. 1952. $3.50.

Here is a book for 1952 gardeners. Dr. Pirone has devoted most of his professional life to the practical solution of plant problems of the average home gardener and householder, and to ways of getting digested technical information to them. In *Modern Gardening* he proves that a plant scientist does not necessarily have to have someone else put his material into language understandable by the layman; he does it himself.

This book is an up-to-date treatment of the culture of garden and household plants, including lawns and trees, together with the treatments for common problems in insect, disease, and weed control. It concludes with a list of 500 common questions and answers on plant problems. Major features are the many tables on insecticides, fungicides, weedicides, and fertilizers, their trade names, constituents, and how to use them. There are also tables on plants for various purposes.

The author is skillful in anticipating the lay gardener's position. He goes right to the point, shows no tendency to skirt issues, keeps his suggestions simple, with a minimum of qualifications, and still is consistently quite sound technically, over an amazingly wide realm of problems.

Dr. Pirone does not believe that we should go back to the ancients for the best methods of gardening, any more than in other fields. He takes sharp issue with the extreme views of some of the organic gardening cult, and shows, with examples from his own experience, the great advantages to be gained from the proper use of the newer chemicals developed to aid the plant grower. He cites how and where to use these materials, including such recent developments as foliage feeding, hormone and other sprays to check growth and fruiting, chemical weed control, and mixed fungicides and insecticides. He does not hesitate to explode many myths concerning plant habits and pet treatments.

The average gardener wants a straightforward answer. Dr. Pirone is adept at this. He tells you what to use, its technical name, some trade names for it, and how much to use. He wades right into the newest materials and tells you what he thinks of them. Along with the accent on the new, he tells the proper use of manures, other organic matter, mulches, etc. It is obvious, however, that he is an enthusiastic believer in the use of chemicals for a wide variety of purposes on plants and in the soil.

Some technical readers may feel that Dr. Pirone occasionally oversimplifies and overdramatizes. For instance, he classifies as diseases the injuries that follow sunscald and overfertilizing, he calls nematodes worms, and says that viruses cannot be seen under the microscope, neglecting to mention that many can be seen under the electron microscope. Such headings as "Medicines For Ailing Plants" and "Garden Miracles" may bother some readers. Since this book's language is primarily intended for the average gardener, however, such liberties are no doubt acceptable.

The professional would also do well to read this book. I find it brings together into one volume a valuable store of practical information, and I expect to find it very helpful in answering gardening questions.

Modern Gardening also contains some brief but interesting background on how some of our better-known agricultural chemicals were discovered and a hopeful peek into the future on the subject of chemicals not yet fully tested but which offer tremendous possibilities in improving plant culture and making it easier and cheaper.

GEORGE H. HEPTING.

The Mahogany Book.
By George N. Lamb. 8th ed., 72 pp. Illus. Mahogany Association, Inc., Chicago 1, Ill. 1951.

Prepared for the architect, the designer, the maker of cabinet work and furniture, and for those who sell and those who buy, this handbook tells the story of mahogany from the tree in the tropical jungle to finished cabinet work of exquisite quality. It is a story that will thrill all lovers of fine cabinet woods. The author has had an experience spanning more than four decades, since graduation as a forester, covering both government and industry affiliation in both domestic and foreign woods.

Although known to Europeans from about 1500, the mahogany tree was first named *Swietenia mahogani* by Jacquin in 1760. This name was accepted by Linnaeus in his 1762 edition of *Species plantarum*, the first edition of which in 1753 marked the beginning of botanical binomial classification. While this scientific name was originally applied to both West Indian and Central American mahogany, it has since been restricted to apply only to mahogany from the West Indies. The banning of the export of mahogany from Cuba beginning in 1946 has virtually eliminated West Indian mahogany from United States markets.

In 1886, tropical American mahogany was recognized as a distinct species and the scientific name changed to *Swietenia macrophylla* King. It includes all mahogany growing on the mainland of Central and South America. Mahogany found on Africa's West Coast was first botanically classified in 1789 by Desrousseaux as *Swietenia senegalensis*. The author traces it from this point to its present name of *Khaya ivorensis*.

Although the author makes it clear that classification of furniture styles at best is imperfect due to overlapping designs, a chronological table of styles covers the period

from about 1500 to 1830. How mahogany found its way into the English royal household before 1725 to start the "Golden Age of Mahogany" (1725 to 1825) is clearly portrayed.

Four outstanding style names, Chippendale, Adam, Hepplewhite and Sheraton, dominated the furniture scene during the 18th century and these are interestingly described. Thomas Sheraton paid this tribute to mahogany: "Of all woods, mahogany is the best suited to furniture where strength is demanded. It works up easily, has a beautiful figure and polishes so well that it is an ornament to any room in which it may be placed."

As the author remarks, "There are no mahogany forests—an average of two trees to the acre being a good stand." In the beginning, only the trees on the river banks were cut. As time marched on, transportation became increasingly more difficult and exploitation extended deeper into the forest. The forest characteristics and physical features of mahogany trees are explained in detail with magnified illustrations of cross-sections and other surfaces. The author describes the laboratory tests that determined the many advantages of mahogany compared with other woods in mortising, boring, planing, shrinking, warping, shaping, turning, and in resistance to termites.

A new departure in this eighth edition is the style of the cover portraying mahogany wood in the stripe or ribbon figure in a variety of finishes from light to dark. A special chapter on figure describes and illustrates how the crotch and mottle figures occur in the tree. Forty color plates show the type figures available. Other chapters relate to mahogany lumber, veneer, plywood, crotch, stripe, mottle, finish, substitutes, antiques, motion pictures, and the wide variety of its uses.

Because of efforts to usurp the good name of mahogany, the Mahogany Association has authorized exclusive copyright labels and tags, and issues them to responsible manufacturers for use on their products under a license which provides severe penalties for misuse. As an aid to buyers of mahogany, the author devotes a page in text and diagrams showing just how to identify substitutes.

HOWARD H. MORGAN,
Lumber & Wood Products Division, National Production Authority.

The Geography of Hunger.

By Josué de Castro. 377 pp. Little, Brown and Company, Boston. 1952. $4.50.

The legend of inexhaustibility dies hard.

Less than half a century ago a generation of self-appointed prophets still preached the inexhaustibility of our forests. They laughed to scorn the morbid fear that wood might ever be in short supply—until reality wrecked their sunny dream world.

But the passion to substitute wishes for unpleasant facts remains irresistible, and today a new crop of professional optimists is training the same rose-tinted glasses on the productivity of the Good Earth. This too they find—inexhaustible.

The latest exponent of this buoyant clan is Dr. Josué de Castro, who has written a book called *The Geography of Hunger*. Cheery standard-bearer of inexhaustibility, Dr. de Castro refuses to be disturbed by the wasting fertility of the world's agricultural land. He finds of only minor significance the forces of erosion that each year claw into uselessness millions of acres of arable soils; and he sees no serious problem in the earth's swiftly mounting populations. This, he tells us, is a matter that can be cured by simply giving the world more food.

By every objective standpoint, *The Geography of Hunger* is a very poor book, and there would be little point in devoting time or space to a review of its bizarre doctrine were it not that the author holds an important chairmanship in the United Nations Food and Agriculture Organization, and because his book is a current selection of the Book Find Club. Also—and one is saddened by the realization—it is a well-meaning book, written by one concerned in raising the world's nutrition standards. Unfortunately, this does not prevent such literary malpractice as *The Geography of Hunger* from doing ponderable harm to the efforts that responsible scientists and land managers are making to banish substandard living from the earth.

It will certainly not aid in the long battle against that arch-destroyer, erosion, to circulate such lighthearted statements as, "Erosion is a cause of soil impoverishment capable of reducing its fertility." This probably wins the all-time Oscar for understatement in view of the millions of acres where erosion has not only reduced soil fertility but has destroyed all capacity for supporting vegetative life. And there will be scant comfort for the millions of farmers whose lands are washing away or being gullied into uselessness to be told that "soil erosion . . . can at most be regarded as capable of causing hunger in future epochs, but never in our era."

At this point one is tempted to exchange Dr. de Castro's lullaby for something more easily credible, such as *Alice in Wonderland*, or *Superman*. But to do so would be to miss several later gems.

One of them is his solution for the control of population. Most scientists have long held the native belief that overpopulation is a major cause of hunger. But the exact opposite, Dr. de Castro explains, is true. Hunger is not the result, it is the cause of overpopulation. "The crucial point of this essay," he writes, "is the argument that overpopulation does not cause starvation . . . but that starvation is the cause of overpopulation."

At this point one may suspect Dr. de Castro of assuming that a starving man, to forget the discomforts of an empty belly, turns to pursuits whose net result is an increased birth rate. But this is not precisely what Dr. de Castro

means. For proteins enter the picture. Proteins, according to Dr. de Castro, decrease human fertility if you take enough of them. So it follows that the obvious solution for too high a birth rate is to feed the world's lusty procreators more proteins.

The discussion here is a little vague, for Dr. de Castro continues to confuse reproductive capacity with growth in numbers. Nor is he the least daunted by absence of convincing evidence that nutritive causes alone reduce the fertility of well-fed populations.

But suppose one accepts this doctrine that more calories mean fewer babies. How do we get the increased food production necessary to beguile the world into such restrained fertility? Dr. de Castro explains this so deftly that one wonders it had not been thought of years ago. He simply conjures up some sixteen billion acres as potentially cultivable—that is, about half the world's land area. To reach this agricultural Utopia, it is necessary, of course, to ignore the belief of most authorities that even to double the two and a half billion acres now being cultivated would involve costly techniques and heroic efforts. Parenthetically, Lord John Boyd-Orr, ex-director of the Food and Agriculture Organization, was under no such illusion of inexhaustibility when he wrote, "The last new land which could easily be brought under the plow was broken during World War War I. Though some old pastures were plowed up during World War II, practically no land which had not previously been cultivated was added to the arable land of the world. We have exploited the last of the world's virgin soils."

Not content with his gross overestimate of the world's potential arable acres, Dr. de Castro next pours from his trusty cornocopia untold quantities of food products from the sea—though nothing so prosaic as a fish. He selects a toothsome green alga called chlorella. This chlorella Dr. de Castro proposes to grow "in huge tanks on minerals and a common gas." A single alga factory can produce enough protein to feed three million people.

And this goes on and on. But let one more example suffice to illustrate the book's rhapsodic tone: "When deserts of ice and impenetrable tropical jungles are being turned into gardens and orchards, when the lands we farm and the plants we grow are being made to multiply their yields, and while we are barely learning how to tap the great food reservoirs of the waters, the wild flora, and of artificial synthesis, the Malthusians go on setting up their sinister scarecrows. It is nothing to us, since we have no reason to fear them."

Buffered by euphoria on such a grand scale, one indeed should have reason to fear nothing in the world. But the peon, scratching in the dust of his sun-baked *milpa*, or the Asiatic, laboring in his tiny rice paddy, will gain from Dr. de Castro's orgy of optimism lean sustenance for himself and his carbohydrate-conceived family.

TOM GILL.

Handbuch der Mikroskopie in der Technik.

Edited by Hugo Freund. 2 vol. Illus. 891 pp. Published by Umschau Verlag, Frankfurt am Main, Germany. 1951. Sold by E. Leitz, Inc., 304 Hudson Street, New York 13. $30.

Although of limited value to American wood technologists generally, since they are written in German, these two volumes constitute an excellent reference in the field of wood and paper technology.

They were compiled by no less than 54 European specialists, many of whom have written individual chapters. The numerous illustrations, mostly from microphotographs, are beautifully reproduced, and the color plates are superb.

The wood chemist and the wood anatomist will find these volumes of more than ordinary interest and value.

Plants For Man.

By Robert W. Schery. 564 pp. Illus. Prentice-Hall, Inc., New York, N. Y. 1952. $10.

Although the author does not state that he intends the book as a textbook of economic botany, it could serve that purpose very well, for it resembles Hill's *Economic Botany* in general outline and content. The subjects treated are: forests and woods; fibers; latex; pectins, gums, resins, oleoresins, and similar exudates; tannins and dyes; essential oils, medicinals, insecticides, and herbicides; tobacco; oils, fats and waxes; sugar and starch; cereals; vegetables; fruits; beverage plants; microorganisms; and miscellanae. It is copiously illustrated with many excellent photographs, charts, diagrams and process flow sheets.

Chapters 3-6, forests available to man, the forest belts of North America, wood and its uses, and the forests, man and the future, could serve as text material for a part of a freshman course in general forestry, or as interesting supplementary reading in such a course.

The forester who is in the position of involuntary neighborhood expert available for over-the-backfence consultation on plants in general will find the book a handy reference volume. Also, the forester who is called upon for garden club lectures, etc. will find many suitable and interesting facts and stories about those plants which are most familar to the layman.

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Compiled by MARTHA MEELIG, *Librarian, The New York State College of Forestry*

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Society Affairs

Officers and Members of the Council, 1952-1953

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Kenneth G. Fensom, President of Canadian Institute of Forestry, Invites S.A.F. Members to Attend Montreal Meeting, November 17-20

In many directions forestry in Canada and in the United States has developed similar patterns. In both countries there have been much the same difficulties in the application of conservation measures and in creating public awareness of the significance of the overall forestry problem. In both countries forestry, over the years, has attained about the same recognition and many of the same trends have been apparent in professional growth and development. Within this framework of duplicating aims and achievements, however, there have been numerous differences in organization, policy, problems, techniques, education, and legislation. Differences between states and within states, and between provinces and within provinces, are sometimes greater than those between countries, but there are common denominators and conditions in each category.

Foresters in Canada have for some years been eagerly anticipating the opportunity to enlarge the scope of their professional knowledge by learning more about the differences and common denominators between Canadian and American forestry — about those phases of American forestry which might have application in Canada and those which might not. Probably no two national groups of foresters have more closely inter-related objectives than those in the United States and Canada, nor more mutual acquaintance, nor more community of interests, nor more sustained personal contact. Over and above these contacts and interchanges of opinion, however, a larger opportunity for the creation of professional understanding was visualized, namely, a joint annual meeting between the two national bodies, the Society of American Foresters and the Canadian Institute of Forestry.

The realization of this meeting has been a target of the Canadian Institute of Forestry for some years past, and in an exchange of correspondence and meetings with officials of the Society of American Foresters interest and enthusiasm were indicated by the latter body to such a decided extent as to encourage the planning of this undertaking for this present year. A joint team of American and Canadian foresters is now completing the necessary arrangements, and it will be a unique and historic occasion when American and Canadian foresters meet at the Mount Royal Hotel, Montreal, November 17th to 20th.

KENNETH G. FENSOM
—C.I.F. President

Although this meeting is being held in Canada, and although the Canadian Institute of Forestry is in a sense the host body, this will be a joint meeting (but with separate business sessions) from the planning stage through to the concluding ceremonies. The majority of those attending will be members of the Society of American Foresters, a number of whom are presenting papers and others of whom are making major contributions in respect to pre-meeting organization. George L. Drake, Henry Clepper, the chairmen of the various technical sessions, and others are providing invaluable assistance. The Canadian effort is consequently only a small fraction of the total, and my only justification in writing these few paragraphs is that, since Canada is being favored as the venue of this first joint annual meeting, it is fitting that Canadian for-

esters through the president of their national professional society should extend a cordial and hearty welcome to all those who will be visiting with us in Montreal in November.

It is fully expected that this meeting, bringing together as it will the foresters of two countries in mutual discussion, will further strengthen bonds of friendship, that it will give impetus to the implementation of new practices and ideas, and that it will develop new understanding of the many problems of North American forestry. We in the Canadian Institute of Forestry are favored by the decision of the Society of American Foresters to meet with us at Montreal, and we will do our very best to make you and your wives comfortable and happy during your stay.

KENNETH G. FENSOM, *President, Canadian Institute of Forestry.*

M. K. Goddard Chairman of Committee on Civil Service

M. K. Goddard, recently appointed head of the Department of Forestry at Pennsylvania State College, succeeding Victor Beede who retired, has also succeeded Prof. Beede as chairman of the S.A.F. Committee on Civil Service.

This committee works closely with the U. S. Civil Service Commission, and other civil service bodies, and is frequently consulted on policy matters with respect to examinations. The committee's latest report was published in the February issue of the JOURNAL OF FORESTRY, pages 153-154.

Other members of the committee are D. S. Jeffers, E. R. Martell, W. C. Percival, and D. J. Weddell.

"The Society of American Foresters and Forestry Education"—A Discussion[1]

When I finished reading Myron Krueger's paper "The Society of American Foresters and Forestry Education"[2] the only simile I could think of was the play *Hamlet*, with Hamlet left out. Hamlet now stands for the issue, raised by the Committee on Accrediting, and confirmed by the Council, that accrediting should no longer be based on the general average attainments and capacity of an institution to turn out competently educated foresters, but instead should be shifted to the basis of minimum curricular requirements expressed in semester hours. Failure to reach these minima carries with it, not for the school, but for the curriculum, the penalty of exclusion of its graduates from Junior Membership on graduation or thereafter, unless the deficiencies in education are made up.

Under the committee which conducted the accreditings of 1935 and 1942, the subject of standard minimum curricula was carefully considered. Graves and Guise had outlined the general course requirements for a basically thorough education in technical forestry in 1932. The decision and policy of the committee and the Council, which was adhered to until 1950, was that a standard for accredited institutions based on a rigid platform of minimum demands in terms of hours of instruction and subjects covered was unworkable, inimical to the evolution of forestry education, would not be accepted by the schools, and would commit the worst error made by certain other accrediting agencies, namely, to try to use the club of accrediting to enforce an imposed pattern of details, instead of weighing all factors influencing the efficiency of the institutions as a whole.

For these reasons, accrediting until 1950 was not placed upon the basis of separate curricula, but instead upon the institution and the school or department as a whole. There were no minimum standards for any of the qualifications that taken together gave the school its standing. Instead of a straight jacket, the school might be weak or below the average in any point provided its average grade was acceptable. Criticisms leveled at the "complicated" system of grading, which in practice worked with quite remarkable accuracy to obtain the overall picture, fell into the trap of assuming that the standards or points, 20 in number, on which the final grade was determined, were minimum standards thus setting up 20 goals to achieve instead of but one. Under this elastic system accrediting worked efficiently and was responsible for great improvement in forestry education, going far to break the strangle hold that agriculture had on forestry in many state institutions.

Based on Graves and Guise' text, it has, however, been accepted that adequate professional training of foresters, as the term had been understood since the profession originated in Europe, required acquaintance with subject matter in five interrelated fields, namely:

Silviculture—the science of growing timber crops.

Management — the business aspects of crop production and disposal.

Economics—the social, political, and economic problems of forestry.

Protection—the special problems attached to the forest including fire, insects, diseases, climate.

Utilization — the handling of the product from stump to consumer.

At this point, Hamlet must enter the stage under the mantle of the curriculum. Now it happens that the alternative of grading curricula instead of schools, rejected or postponed until 1950 by the Society, is double barreled. In the engineering schools it is a simple matter to accredit separately the curricula in different branches, such as civil, mechanical, and electrical, for these constitute specialties, and actually are represented in the engineering profession by separate societies. In forestry education we are squarely up against the question of defining what is meant by the term "forester," in a professional sense. Can we in turn, like the engineers, split our profession into compartments? True, we can specialize and must do so in any of the five above general fields. But can this specialization proceed to the point that it represents training and interests so diverse that the graduates must coordinate their postgraduate activities by adhering to separate societies? This after all is what it comes down to. Barring the insistence on five years of educational training to provide time for acquiring a rigid minimum requirement in all five groups, plus the needed training in the specialty, the schools, in 4-year curricula, are going to make their own decisions as to the extent of instruction they can offer in related but different groups. The Society, not having the power to determine for the schools what the latter decide to teach, can only influence instruction by exclusion from its membership of graduates of curricula not meeting its minimum requirements.

As we know, this question was the subject of a referendum. (JOURNAL OF

[1] Presented at a meeting of the Division of Education, Society of American Foresters, Biloxi, Miss., December 12, 1951.

[2] Presented at a meeting of the Division of Education, Biloxi, December 12, 1951; and published in the JOURNAL OF FORESTRY, January 1952, pp. 6-7.

FORESTRY, Jan. 1950, p. 56.) The issue was whether the Society should include as Junior Members, "men of professional training equivalent to that required in forestry, in any form of wild land management, such as range, wildlife, recreation, water, and soil, without distinction as to cover types." The vote was *Yes*, 1506; *No*, 2036. The implications of this referendum were obviously that curricula, in the subjects designated, should be rejected as the basis for Junior Membership. I was not impressed with the discussion preceding this ballot, considered it inadequate, and was convinced by the size of the affirmative vote that basic considerations had not been explained adequately. The outstanding fact was that in the fields of range management, in wildlife, and in soils, separate professional societies were flourishing, thus paralleling the case of the engineers, and emphasizing the similar reasons for rejecting these curricula for Junior Members of S.A.F. I wish to emphasize the fact that the wording of this referendum did not allude in any way to utilization. The subjects voted on were related to forestry, but required a separate curriculum not dependent on minimum grounding in the 5 forestry groups, and were served by separate professional organizations. This referendum may have created an inference as to the treatment of specialized curricula in wood utilization, but did not in itself sanction the exclusion of these special curricula. It was significant that the Council held a referendum on the subject of these allied fields of wildland management instead of proceeding on the assumption that power was given it under the constitution to accredit or refuse to accredit curricula rather than schools. It is also important to note that the grade of Member is open to men specializing in all of the fields (Bylaw 6c) in which Junior Membership was denied by the referendum—the distinction being that these men had been educated in curricula that bore the forestry label.

It is also historically established that the Council, under Art. III, Sec. 4, of the Constitution, has consistently taken the position that it had the authority to determine what shall constitute "an understanding of the basic economic, business, and technical facts and principles sufficient for the foundation of a professional career in forestry," although nowhere in the Constitution, prior to the referendum of 1949, was the word *curriculum* mentioned but always *school*. The Council's position as to its authority on this matter was stated repeatedly. (J.F. 34: 342; 35: 46; SAF Affairs Jan. '37:4; J.F. 35: 345; SAF Affairs 38:23.) In 1937 the President proposed a set of minimum requirements to insure adequate grounding in the 5 groups (J.F. 35:43) and in that same year specified utilization as one of the special curricula whose graduates should be subject to these qualifications. Hence in finally taking action to establish minimum curricula for qualifying graduates in the special field of wood utilization and technology, for Junior grade, the Council was not departing from announced previous declarations of authority. Yet the only specific instance or precedent in which it exerted this authority was in disqualifying a single curriculum in pulp and paper making at the New York State College of Forestry at Syracuse, in 1938. Proof of this position is found in Bylaw 5 of long standing, Class A, for graduates of a school of forestry approved by the Council. "Authoritative statement should be given as to the degree received and the *curriculum taken, which must be one that has been approved by the Council as covering the basic requirements of Junior membership.*"

Nevertheless, the specific provision that the Council shall have power to accredit curricula in utilization, instead of schools, has never been incorporated in the Constitution nor been adopted as an amendment to the Constitution by referendum vote. Not until the referendum of 1949 (J.F. 48:56) was the subject of approval or disapproval of curricula in the allied subjects relating to wild land management decided and so incorporated.

This brings us to the last phase of a situation where by reasoning, inference, and analogy, the Council exercised its assumed inherent authority to set up minimum requirements aimed specifically at curricula in wood technology and utilization. The occasion was the referendum on Student Membership requirements. In Article III as amended, Student Members shall be junior or senior students, or graduate students not eligible for the Junior Member grade, regularly enrolled in *approved curricula* at accredited schools of forestry.

My assertion here is that this amendment in itself, though it obviously requires the Council to pass on the curricula rather than the school for qualifying Student Members, does nothing to change the status of *graduates* in curricula not approved by the Council, provided the school has been approved. Hence, as far as the Constitution goes (but not the bylaws), graduates in wood technology and utilization could under the present constitution be admitted as they always have been so far, though deficient in some of the other 4 groups. In support of this "hair splitting" I find that in the remaining changes in the Constitution, adopted in this referendum, no mention is made of *curricula*, but always of *schools*. (Art. IV, Sec. 1; Sec. 2, pars. 2 and 3.) If the word curriculum had been substituted for school in these amendments, which was not done, the members in voting would have known that they were empowering the Council through the Constitution to substitute curricula as the basis for Junior, not exclusively Student Membership. The Council endeavored to make this point clear as to intention, by publishing with the referendum the proposed changes in the bylaws. Bylaw 5 specifies for Junior Membership, Class A, approved curricula and also sets up the minimum requirements for such approval.

Despite these efforts, the referendum itself dealt solely with requirements for the Student grade, and as stated, did not clarify the Constitution as to Junior qualifications. In order to defeat the proposed bylaws, the members would have had to vote against the incorporation of the Student grade itself. This point was so obscure that not until the Committee on Accrediting proposed and the Council adopted the classification of accredited and non-accredited curricula in wood utilization and technology was the significance of this action grasped by those schools that were hit.

So far, this discussion has been an attempt to clarify the issue. There remain two questions to settle:

1. Does the profession of forestry, by definition, require adequate technical training in all five groups, namely, silviculture, management, economics, protection, and utilization, as the basis for classification as a forester — afterwards permitting any amount of specialization, or is it considered that specialization in any one of these five groups, with inadequate basic grounding in all four of the other groups, will so qualify them?

2. What procedure is necessary to arrive at a decision on the question which the Council, not the members, has determined, in the case of the specialty, forest technology and utilization?

Discussing the second question, my opinion is that it should be decided by a referendum vote as was done in

the case of the allied subjects, in which fields professional societies of their own best serve their interests. But this should be done only after full discussion in the JOURNAL.

As to the first question, the Society will have to choose between insisting on the broad coverage of basic requirements that have so far been set up, as the preliminary to specialization in any group, or the alternative of accepting wood technology and utilization as a separate division of the profession, with forest production as its Siamese twin. There is no basis for anticipating that this splinter process will extend further, so that one could concentrate solely on silviculture (an acrimonous and false charge often leveled at opponents of the inclusion of wild land management specialists) or on management or protection, or even on economics, without possessing adequate knowledge of the other three groups, and still be regarded as eligible to Junior Membership.

Nor should the question be argued on the line of the indispensability of utilization, or reaching the ultimate consumer, in forestry, for we know that consumption, distribution, and manufacture are as indispensable to production as are flour mills and retail stores to the farmer. Yet in these other fields, including livestock, the distinctions between producer, processor, and sales do not cause any confusion as to the identity of the farmer or stockman.

In my opinion, it is a waste of time to point out that demand for wood, and the processes of manufacture and distribution, are so indispensable to production of timber that the latter stands or falls by the former. The reverse is equally true.

Whether or not the Society wants to admit graduates in wood technology and utilization as Junior Members, who have insufficient knowledge of forest production, will be decided on the basis that the connection, in forestry, between these two parts of the whole is so close and dovetailed that we simply cannot afford to split them asunder.

Actually, the harvesting of the crop is as much a part of production in forestry as it is in agriculture or horticulture. Shall specialists in logging and lumbering be excluded? Manufacturing or milling is again closely bound up with production, both in operation and in land ownership and management. Shall men trained only in the above specialties be excluded? Needless to say, products shaped in final form by the grower, such as crossties, poles and piling, do not give rise to doubts. When it comes to end products, such as furniture manufacturing, pulp and paper making, building construction, and lumber sales, we may begin to wonder how inclusive forestry can be, for these specialists need know nothing whatever about growing timber or managing forests, except to express preference for certain species, qualities, and grades.

What would we do, split wood technology and utilization down the middle somewhere, and thus separate the sheep from the goats?

Another important consideration, tied in with the precedents already established, is whether wood technologists and utilization men prefer, themselves, to affiliate solely with professional societies confined to their own field. How much bearing on this subject has the Forest Products Research Society for instance? This is not a "section" of an inclusive society of foresters, but separate organization. True, it is possible to be members of two professional societies, as instanced by the splinter group of consulting foresters, an occupational organization not itself a member of the Society but composed largely of Society members. Would this hold true for the Forest Products Research Society, or do their members as a rule prefer to affiliate only with their own group?

In the older countries it is my belief that a forester specializes only on the basis of full fundamental instruction in the 5 groups, and is known as a professional forester on that basis, though I may be wrong.

What I am trying to say is that the Society is faced with a decision which means the acceptance of men adequately trained in one, but not in the other four, of the five basic groups, four of which deal with forest production, and the other with what happens to the raw products.

It also means that these men will have a free choice between allying themselves professionally with the production group in the S.A.F. or concentrating solely on their own field of utilization and technology.

To exclude these specialists on the ground that their training in production is inadequate deprives them of this choice and the Society of their active cooperation in solving the innumerable problems concerned with harmonizing production and consumption of wood.

Since I do not wish to leave this subject up in the air, I will simply state that as long as all the implications of the problem are clearly understood, I believe that the Society could well afford to waive the minimum requirements for wood utilization and technology, pending a future millenium in which through the adoption of 5-year curricula, the coverage of the production group of subjects could be made practicable without impairing efficiency in training for these special purposes. Meanwhile, the curricula in the 4 groups concerned with production, including economics, can be expected to continue to require proper basic instruction in the fifth field, utilization and technology, just as we may hope that it will be possible eventually to expect the utilization group to realize the benefit of knowing more than superficially the basis of production of their raw material.

H. H. CHAPMAN.

Chapters Continue to Grow

For some years groups of local foresters met informally to discuss mutual problems and visit nearby forestry operations. Increased interest and attendance resulted in the establishment of Chapters, which now number over sixty. Three Chapters were established this year—New Hampshire (New England Section); Southeast Texas (Gulf States Section); and Hiawatha (Wisconsin-Upper Michigan Section).

Chapters, generally informally organized, offer to isolated members opportunity for professional enrichment and a wider participation in Society affairs. Frequent attendance at Chapter meetings is mutually rewarding to the member, Section, and profession.

It is suggested that members located in the territory covered by any one of the Chapters write to the secretary of the Section for information regarding Chapter affiliation. A list of Section officers appears in the March JOURNAL OF FORESTRY, page 233.

Following is a list of Chapters as of April 30th.

Allegheny Section

1. New Jersey
2. Philadelphia
3. West Virginia

Central Rocky Mountain Section

1. Black Hills

Central States Section

1. Illinois Technical Forestry Association

2. Indiana
3. Lower Michigan
4. Ohio

Columbia River Section

1. Central Oregon
2. Hawaii
3. Longview
4. Portland
5. Shasta-Cascade
6. Siskiyou
7. Umpqua-Coquille
8. Willamette

Gulf States Section

1. Fort Worth-Dallas
2. Houston-Huntsville-College Station
3. Jackson
4. Longleaf
5. Lufkin-Nacogdoches
6. North Louisiana
7. North Mississippi
8. Florida Parishes
9. Southeast Texas
10. Southwest Louisiana

New England Section

1. New Hampshire

New York Section

1. Adirondack
2. Black River Valley
3. Capital District
4. Iroquois
5. Longhouse
6. Metropolitan
7. Mid-Hudson
8. Ontario
9. Upper Hudson
10. Western New York

Northern California Section

1. Bay Area
2. Eldorado-Amador
3. Feather River
4. Redding
5. Redwood
6. Sacramento
7. San Joaquin

Ozark Section

1. Missouri
2. Oklahoma
3. Southeast Arkansas

Puget Sound Section

1. Alaska
2. British Columbia
3. North Olympic
4. Southwest Washington

Southeastern Section

1. Alabama
2. Florida
3. Georgia

Upper Mississippi Valley Section

1. Iowa
2. Lake Superior
3. North Dakota
4. Northwest
5. Southern

Wisconsin-Upper Michigan Section

1. Hiawatha
2. Madison
3. Milwaukee
4. Northeastern Wisconsin

American Forest Products Industries Photo.

KENTUCKY-TENNESSEE SECTION HONORS PUBLISHERS: Outstanding contributions to the cause of good forestry earned Herman E. Baggenstoss, *left*, this award from the Kentucky-Tennessee Section of the Society of American Foresters. Mr. Baggenstoss is publisher and editor of the *Grundy County Herald* at Tracy City, Tenn. J. O. Artman, *right*, Tennessee Valley Authority forester, made the presentation. Baggenstoss owns a 6,600-acre Tennessee Tree Farm and uses the columns of his newspaper to sell good forest management policies to readers. He is chairman of the State Conservation Commission. In presenting the award, Mr. Artman declared: "Foresters know pretty well how to get forestland into full production and how to keep it producing on a continuous basis. But, in many instances, they are kept from putting this knowledge into practice by a lack of understanding and interest on the part of forestland owners. The obvious solution is public education. In this democracy of ours the newspaper is still one of the best means to that end."

Candidates for Membership

Candidates for admission (except those for the Student Member grade), advancement, or reinstatement whose membership applications were received in the Society office during the month of April are listed below.

Action regarding the eligibility of these candidates will be taken by the Council as of July 1, 1952. Any communications from voting members relating to the membership eligibility of any of these candidates should be received in the Society office prior to that date.

The names of these candidates who become members of the grade for which they have applied will be published in subsequent issues of the JOURNAL OF FORESTRY.

Allegheny Section

Junior Grade

Johns, R. P., 534 Windcrest, State College, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Johnson, W. E., 225 Windcrest, State College, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Kalafus, J., Jr., Tau Phi Delta, State College, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Keeley, C. A., Asst. Dist. Forester, Md. Dept. of Forests and Parks, Laurel, Md.; Pa. State, B.S.F., 1948.

Klinefelter, F. W., Jr., 846 E. Philadelphia St., York, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Kronk, M. E., 1803 Boundary St., Aliquippa, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Landis, G. H., 129 S. Miles St., State College, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Lylo, N., 1418 Second Ave., Berwick, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Nelson, J. C., Ludlow, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Potter, R. V., 134 E. Hazard St., Summit Hill, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Ruth, J. D., 946 Butler St., Easton, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Van Devender, I. G., Tbr. Inspt., O. Ames Co., Parkersburg, W. Va.; W. Va. Univ., B.S.F., 1950.

Wagner, J. F., 210 West St., Williamstown, Pa.; Pa. State, B.S.F., 1952. (Student, 1951).

Member Grade

Covel, C. E., Asst. Dist. Forester, Dept. of Forests and Parks, Frederick, Md.; Univ. of Mich., B.S.F., 1937; M.F., 1939. (Junior, 1945).

Disque, K. F., Park Supt., Dept. of Forests and Waters, Jamestown, Pa.; Pa. State, B.S.F., 1939. (Junior, 1946).

Appalachian Section

Junior Grade

Parsons, W. E., U.S. Army Engineers, South Hill, Va.; Univ. of Me., B.S.F., 1927. Reinstatement.

Price, D. H., Forester, Taylor Lbr. Co., Wallace N. C.; N. C. State, B.S.F., 1950.

Central Rocky Mountain Section

Junior Grade

Brown, M. C., Service Forester, Colo. State Board of Forestry, Denver, Colo.; Colo. A & M., B.S.F., 1952.

Central States Section

Junior Grade

Eberhardt, W. E., 319 Lloyd House, Ann Arbor, Mich., Univ. of Mich., B.S.F., 1952. (Student, 1951).

Miller, S. R., 260 Canaris St., Constantine, Mich.; Univ. of Mich., B.S.F., 1952. (Student, 1951).

Wilson, E. F., City Forester, 210½ Colfax Ave., La Porte, Ind.; Purdue Univ., B.S.F., 1950.

Member Grade

Elston, J. D., Mgr., Research Lab., General Box Co., Des Plaines, Ill.; Univ. of Minn., B.S.F., 1937; Yale, M.F., 1946. (Junior 1946.)

Frisby, S. A., Owner, Freeport Thr. Products, Freeport, Ill.; Univ. of Minn., B.S.F., 1931. (Junior, 1939).

Morgan, H. L., Asst. Woods Mgr., Mead Corp., Chillicothe, Ohio.; Univ. of Ga., B.S.F., 1946; M.F., 1947. (Junior, 1947).

Van Camp, J. C., Salesman, Home Lbr. and Supply Co., Rockford, Ill.; Purdue Univ., B.S.F., 1942; Yale, M.F., 1947. (Junior, 43R46).

Affiliate Grade

Bailey, C. V., Nursery Supt., Dept. of Natural Resources, Green Springs, Ohio.

Columbia River Section

Junior Grade

Davis, G., Forester, U.S.F.S., Prineville, Oreg.; Pa. State, B.S.F., 1949; M.S., 1951.

Eimstad, W. A., Transitman, Booth Kelly Lbr. Co., Eugene, Oreg.; Oregon State, B.S.F., 1950.

Tracy, R. H., Jr., Forester, U.S.F.S., Butte Falls Rgr. Sta., Butte Falls, Oreg.; Colo. A & M., B.S.F., 1951.

Wray, C. J., Forester, C. L. Pine Lbr. Co., John Day, Oreg.; State College of Wash., B.S., (Forestry), 1950; Duke Univ., M. F., 1951.

Member Grade

Chambers, W. F., Forester, Bohemia Lbr. Co., Culp Creek, Oreg.; Univ. of Calif., B.S.F., 1947. (Junior, 1947).

Dahlin, V. W., Forester, U.S.F.S., Medford, Oreg. (Junior, 1949).

Freed, H. W., Asst. Mgr., Longview Fibre Co., Longview, Wash.; Oregon State, B.S.L.E., 1941. (Junior, 1947).

Holmes, A. W., Thr. Buyer, Columbia-Hudson Lbr. Co., Portland, Oreg.; Univ. of Calif., B.S.F., 1947. (Junior, 1947).

Johnson, R. E., Forester and Logging Engr., Hult Lbr. Co., Horton, Oreg.; Univ. of Wash., B.S.F., 1940. (Junior, 1946).

Smith, L. G., Logging Supt., Lakeview, Oreg.; Oregon State, B.S.F., 1937. (Junior, 1945).

Gulf States Section

Member Grade

Grigsby, H. C., Grad. Student, La. State Univ., Baton Rouge, La.; La. State, B.S.F., 1947; M.S., 1952. (Junior, 1949).

Affiliate Grade

Bozeman, C. A., Dist. Forester, Miss. Forest Service, Jackson, Miss.; Miss. State College, B.S., (Agric.), 1940.

Roraback, G. L., Dist. Forester, Int. Paper Co., Quitman, Miss.

Walley, L., Dist. Forester, Masonite Corp., Richton, Miss.

Intermountain Section

Junior Grade

Deinema, J. W., Forester, U.S.F.S., Challis, Idaho; Iowa State, B.S.F., 1949.

Member Grade

Taylor, F. H., Staff Asst., U.S.F.S., Burley, Idaho; Univ. of Idaho, B.S.F., 1938. (Junior, 1945).

Thompson, E. L., Forester, U.S.F.S., McCall, Idaho; Univ. of Idaho, B.S.F., 1938. (Junior, 1946).

Kentucky-Tennessee Section

Member Grade

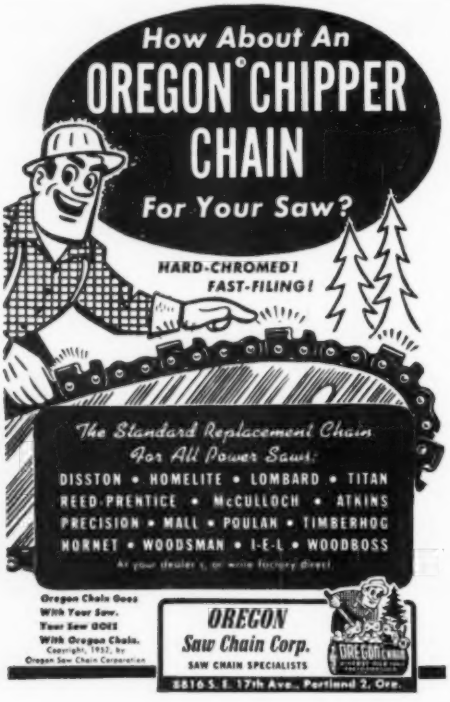
Whipple, S. D., Supt. of Forests, Berea College, Berea, Ky.; Univ. of Mich., B.S.F., 1947; M.F., 1947. (Junior, 1948).

Affiliate Grade

Cundy, C. Y., Box 164, Lucy, Tenn.; Mich. College of Mining and Tech., B.S., (Forestry), 1950.

Associate Grade

Shanks, R. E., Prof., Dept. of Botany, Univ. of Tenn., Knoxville, Tenn.; Ohio Northern Univ., A.B., (Biology), 1933; Ohio State Univ., M.S., (Botany), 1937, (Ph. D., 1938).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March, J. B., Forest Supv., Mass. Div. of Forestry, Middleboro, Mass.; Univ. of Me., B.S.F., 1951.

Affiliate Grade

Roberts, E. W., Mgr., J. W. Sewall Co., Ltd., Fredericton, N. B., Canada; Univ. of N. B., B.S. (Forestry), 1946.

New York Section

Junior Grade

LaDue, F. M., Box 146, Harrisville, N. Y.; Univ. of Mich., B.S.F., 1952. (Student, 1952).

Widli, J. R., 1207 Waring Ave., N.Y., N. Y.; Univ. of Mich., B.S.F., 1952. (Student, 1952).

Member Grade

Core, H. A., Instructor, College of Forestry, State Univ. of New York, Syracuse, N. Y.; W. Va. Univ., B.S.F., 1942; State Univ. of N. Y., M.S., 1949. (Junior, 1947).

Gatdula, P., Town and Country Landscaping, Watervliet, N. Y.; Pa. State, B.S.F., 1942; M.F., 1947. (Junior, 1944).

Associate Grade

Kugelman, L. J., Woodland Mgr., Int. Paper Co., N.Y., N. Y.; Dartmouth College, B.S., (Economics), 1924; Tuck School, M.C.S., (Business Adm.), 1925.

Northern California Section

Junior Grade

Clifford, P. G., Calif. Forest and Range Exp. Sta., Berkeley, Calif.; Univ. of Me., B.S.F., 1948.

Hall, S. D., Thr. Mgmt. Aide, U.S.F.S., Happy Camp, Calif.; Pa. State, B.S.F., 1951.

Heyer, J., Asst. Dist. Forester, Southern Pacific Co., San Francisco, Calif.; Univ. of Calif., B.S.F., 1941.

Riley, J. D., Asst. Log Supt., Willets Redwood Products, Willets, Calif. (Aff., 1949).

Torvinen, J. W., Engr. Aide, U.S.D.A., Placerville, Calif.; Utah State Agric. College, B.S.F., 1950.

Tripp, C. E., Forester, U.S.F.S., Nevada City, Calif.; Univ. of Me., B.S.F., 1951.

Werner, R. N., Forester, U.S.F.S., Nevada City, Calif; Univ. of Mich., B.S.F., 1950.

Member Grade

Flenger, J. P., Forester, Cheney Lbr. Co., Burney, Calif.; Oregon State, B.S.F., 1945. (Junior, 1946).

Hartong, A. L., Forester, U.S.F.S., Berkeley, Calif.; Colo. A & M., B.S.F., 1942; Univ. of Mich., M.F., 1946. (Junior, 1946).

Masson, J. H., Asst. Forester, Collins Pine Co., Chester, Calif.; Univ. of Calif., B.S.F., 1946. (Junior, 1947).

Taylor, J. N., Box 72, Ben Lomond, Calif.; Univ. of Minn., B.S.F., 1939. (Junior 40R47).

Northern Rocky Mountain Section

Junior Grade

Covey, H. L., Scaler, Western Mont. Lbr. Co., Missoula, Mont.; Mont. State Univ., B.S.F., 1951.

Ozark Section

Junior Grade

Chancey, T. S., Dist. Forester, Dierks Lbr. and Coal Co., Mountain Pine, Ark.; Univ. of Calif., B.S.F., 1949.

Eggers, K. W., St. Louis Rd., Jefferson City, Mo.; Univ. of Mo., B.S.F., 1952. (Student, 1951).

Illinik, R. H., 1218 Griefield Place, St. Louis, Mo.; Univ. of Mo., B.S.F., 1952. (Student, 1951).

Lenz, M. T. J., Asst. Block Forester, Dierks Lbr. and Coal Co., Broken Bow, Okla.; Iowa State, B.S.F., 1950.

Ottomeyer, D. J., 515 Rollins, Columbia, Mo.; Univ. of Mo.; B.S.F., 1952. (Student, 1951).

Poston, W. E., Asst. Block Forester, Dierks Lbr. and Coal Co., Broken Bow, Okla.; Iowa State, B.S.F., 1949.

Sander, I. L., 210 Fairway Village, Columbia, Mo.; Univ. of Mo., B.S.F., 1952. (Student, 1951).

Steger, P. J., 2436 Wesmer, Overland, Mo.; Univ. of Mo., B.S.F., 1952. (Student, 1951).

Vandeven, J. A., 124 South Pacific, Cape Girardeau, Mo.; Univ. of Mo., B.S.F., 1952. (Student, 1951).

Member Grade

Hunt, O. R., Dist. Forester, Dierks Lbr. and Coal Co., DeQueen, Ark.; Colo. A. & M., B.S.F., 1946. (Junior, 1949).

Puget Sound Section

Junior Grade

Hawley, G. O., Jr., Forester, Port Blakeley Mill Co., Seattle, Wash.; Univ. of Wash., B.S.F., 1949.

Munnich, H. F., Box 104, Omak, Wash.; Univ. of Wash., B.S.F., 1950.

Pierce, J. R., 510 3rd Ave. S., Kent, Wash.; Univ. of Wash., B.S.F., 1952 (Student, 1951).

Smith, C. L., Kosmos Thr. Co., Kosmos, Wash.; Univ. of Minn., B.S.F., 1952. (Student, 1951).

Wise, E. E., Forester, St. Regis Paper Co., Tacoma, Wash.; Univ. of Wash., B.S.F., 1950.

Member Grade

Williams, C., Forester, U.S.F.S., Darrington, Wash.; Univ. of Wash., B.S.F., 1937. (Junior, 1946).

Affiliate Grade

Hanlin, R. L., Thr. Buyer, Baker-Gardner Mills, Inc., Bremerton, Wash.; Univ. of Wash., B. S., (Forest Products), 1950.

McKeever, L. C., Forester, U.S. Indian Service, Hoquiam, Wash.

Southeastern Section

Junior Grade

Crown, W. L., Jr., 4286 Baltic St., Jacksonville, Fla.; Univ. of Fla., B.S.F., 1952. (Student, 1951).

Dew, E. S., Asst. Dist. Forester, St. Joe Paper Co., West Bay, Fla.; Univ. of Fla., B.S.F., 1951.

Member Grade

Aycock, M. S., Cons. Forester, Union Bag and Paper Corp., Savannah, Ga.; Univ. of Ga., B.S.F., 1938. (Junior 36R47).

Battle, O. K., Forester, Holly Springs Lbr. Co., Atlanta, Ga.; Univ. of Ga., B.S.F., 1945. (Junior, 1945).

Groom, P. W., Thr. Mgmt., St. Joe Paper Co., Wewahitchka, Fla.; Univ. of Ga., B.S.F., 1942. (Junior, 1943).

Hodgkins, E. J., Assoc. Prof. of Forestry, A.P.I., Auburn, Ala.; Mich. State, B.S.F., 1938; Univ. of Calif., M.S., 1940. (Junior, 1945).

Hudson, J. E., Forester and Mgr., Harry M. Smith Co., Lake Butler, Fla. (Junior, 1945).

Snyder, R. L., Proj. Forester, Ala. Dept. of Cons., Montgomery, Ala.; Norwich Univ., B.S., 1933; Yale, M.F., 1935. (Junior, 1936).

Tomlinson, H. R., Forester, U.S.F.S., Atlanta, Ga.; Yale, B.S., 1930; M.F., 1931. (Junior, 34R52).

Affiliate Grade

Gibbs, G. A., Dist. Supt., Wood Procurement, Int. Paper Co., Gainesville, Fla.

Southwestern Section

Member Grade

Murray, I. P., 2403 N. Arnold, Albuquerque, N. Mex.; Colo. A. & M., B.S.F., 1933. Reinstatement.

Affiliate Grade

Davis, J. D., Sr., Forester, Bureau of Land Mgmt., Albuquerque, N. Mex.; Univ. of N. H., B. S., (Forestry), 1950.

Upper Mississippi Valley Section

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Austbo, J. A., 119 W. Bridge St., Redwood Falls, Minn.; Univ. of Minn., B.S.F., 1952. (Student, 1952).

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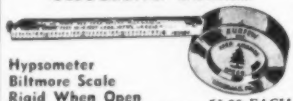

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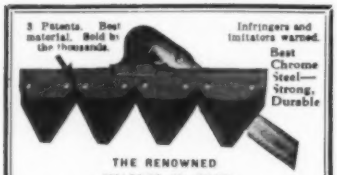

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Campbell, R., 2298 Foiwell St., St. Paul, Minn.; Univ. of Minn., B.S.F., 1952 (Student, 1952).
Gruetzman, S. A., Forester, Iron Range Resources and Rehabilitation, Hibbing, Minn.; Univ. of Minn., B.S.F., 1951.
Sterle, J. R., University Village, Minneapolis, Minn.; Univ. of Minn., B.S.F., 1952. (Student, 1952).

Washington Section

Junior Grade

Conts, K. W., 1947 Biltmore St., N. W., Washington, D. C.; State Univ. of New York, B.S.F., 1952. (Student, 1951).
Martinck, J. A., Trainee, National Park Service, Washington, D. C.; Mich. State, B.S.F., 1949.

Wisconsin-Upper Michigan

Junior Grade

Hammond, R. C., Safety Engr., Mich.-Wisconsin Forest Prod. Safety Council, Rhinelander, Wisc.; Iowa State, B.S.F., 1949.
Loftus, N. J., Forester, Rhinelander Paper Co., Rhinelander, Wisc.; Purdue, B.S.F., 1949.
Mirkes, L. H., 508 S. Weed St., Shawano, Wisc.; Univ. of Minn., B.S.F., 1952. (Student, 1951).
Mueller, C. S., Forester, Wisconsin Cons. Dept., Tomahawk, Wisc.; Mich. State, B.S.F., 1950.
Sheldon, K. G., Chief Forester, Rhinelander Paper Co., Rhinelander, Wisc.; State Univ. of New York, B.S.F., 1950; M.F., 1951.
Strengberg, M. L., Asst. Forester, Patten Logging Co., Arenac, Mich.; B.S.F. Mich State, 1941.
Tonkin, C. H., Scaler, Marquette Veneer Co., Marquette, Mich.; Univ. of Mich., B.S.F., 1951.

Member Grade

Beale, J. A., Area Supv., Wisc. Cons. Dept., Wisconsin Rapids, Wisc.; Mich. State, B.S.F., 1940. (Junior, 1946).
Hopp, E. L., Forester, National Container Corp. of Mich., Ontonagon, Mich.; Iowa State, B.S.F., 1947. (Junior, 1948).
Lenz, W. E., Sales Repre., Winton Lbr. Sales Co., Elm Grove, Wisc.; Univ. of Mich., B.S.F., 1941. (Junior, 1945).
Steinhilb, H. M., Asst. Prof. of Forestry, Mich. College of Mining and Tech., Houghton, Mich.; Mich. College of Mining and Tech., B.S., (Forestry), 1940; Mich. State, M. S., 1951. (Junior, 1947).

Affiliate Grade

Todd, W. A., Forester, Longyear Estate, Inc. and Kewenaw Land Assoc., Ltd., Marquette, Mich.; Mich. College of Mining and Tech., B.S., (Forestry), 1948.

New Members and Advancements

Individuals who became members of the grades indicated during the month of April are listed below. They are eligible for participation in activities of the Society of American Foresters, including meetings and projects of Sections, Chapters, Divisions, and Committees.

Allegheny Section

Student Grade

PENNSYLVANIA STATE COLLEGE

Harms, W. R.
Kepler, B. J.
McCarthy, R. J.
Polak, W.
Pope, A. A.

Central States Section

Junior Grade

Ober, M. G., Box 268, Red Jacket, W. Va.
Norris, T. L., Romney, W. Va.
Warder, B. J., 435 Winchester Ave., Martinsburg, W. Va.

Appalachian Section

Junior Grade

Barden, C. F., Box 458, Kingstree, S. C.
Lamb, G. E., 16 Carrier St., Asheville, N. C.
Phillips, J. H., Jr., 108 Church St., Nashville, N. C.
Williams, W. D., 508 N. Ocean Blvd., Myrtle Beach, S. C.

Central Rocky Mountain Section

Junior Grade

Pritchard, D. R., Jr., 808 S. Clarkson St., Denver, Colo.
Tromsness, H. L., Gen. Del., Cowdrey, Colo.

Central States Section

Student Grade

UNIVERSITY OF MICHIGAN

Brokaw, F. C.

Junior Grade

Barnes, B., 1103 E. Washington St., Ann Arbor, Mich.
Benham, J. G., 334 S. Grant St., W. Lafayette, Ind.
Campbell, R. L., 330 Woodlawn, Cambridge, Ohio
Croxton, R. J., 112 S. Grant St., W. Lafayette, Ind.
Freeman, F. W., Route No. 2, Rockbridge, Ohio
Garrett, H. R., 150 S. Westmoor Ave., Columbus, Ohio
Heazlit, C. E., 1105 17th St., Portsmouth, Ohio
Kuhne, E. R., Box 72, Hart, Mich.
Nordli, R. C., 21 Cherry Lane Heights, W. Lafayette, Ind.
Pruett, E., 21 N. Lafayette St., Oolitic, Ind.
Scher, T. G., 5495 Dorchester Ave., Chicago, Ill.

Columbia River Section

Junior Grade

Betts, J. W., 204 Colorado St., Bend, Oreg.
Calder, D. G., 1828 Hilyard, Eugene, Oreg.
Hartman, G. B., Jr., c/o Edward Hines Lbr Co., Hines, Oreg.
Hohenhaus, R. A., 2267 Shelton, Salem, Oreg
Karlinger, E. M., 1445 E. 2nd Ave., S., Roseburg, Oreg.
Mitchell, H. W., Mapleton, Oreg.
Romero, E., c o U.S.F.S., Bend, Oreg.
Smith, W. A., 1546 Oak St., Eugene, Oreg.
Sullivan, R. C., Gen. Del., Pacific City, Oreg.
Vogel, L. A., 310 S. 15th St., Corvallis, Oreg.

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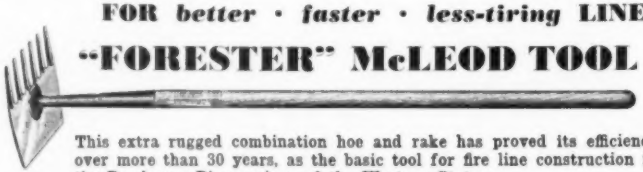

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Healy, R. S., 315 North Chadwick, Roseburg, Oreg.
Ramer, R. J., Box 412, Klamath Falls, Oreg.
Sandor, J. A., 423 U.S. Court House, Portland, Oreg.

Gulf States Section

Junior Grade

Adams, M. C., 339 N. Church St., Tupelo, Miss.
Bonsier, C. A., Kirby Lbr. Corp., Cleveland, Texas
Romero, L. H., Box 3415, W. Monroe, La.

Member Grade

McConnell, W. V., Box 380, Lufkin, Texas

Affiliate Grade

Burks, L. L., Uranis, La.
Jiles, R. A., Jr., Ruston, La.
Keck, W. G., Box 960, Hammond, La.
Lamkin, S. W., 1008 S. Fredonia, Nacogdoches, Texas
Wilson, E., S. W. Settlement and Development Corp., Jasper, Tex.

Inland Empire Section

Student Grade

UNIVERSITY OF IDAHO
Nagle, W. P.

Junior Grade

Kern, C. P., Pierce, Idaho

Intermountain Section

Student Grade

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Krygier, J. T.

Kentucky-Tennessee Section

Junior Grade

Amrhein, G. C., 16 Riggs Ave., Erlanger, Ky.
Morrett, C. M., 318 High St., Somerset, Ky.

Member Grade

Oren, E. A., S.C.S., Lexington, Ky.

New England Section

Junior Grade

Burgess, S. L., Box 308, Dixfield, Me.
Curtis, R. O., c/o Walter E. Curtis, Baldwinville, Mass.
Mergen, F., Yale School of Forestry, New Haven, Conn.
Parsons, J. W., 20 Avalon Place, Wethersfield, Conn.

Member Grade

Goodhue, S., Box 86, Lincoln, N. H.

Affiliate Grade

Lucy, A. K., Conway Supply Co., Conway, N. H.
Rivard, J. F., Canadian Int. Paper Co., Trois Rivieres, Quebec, Canada.

New York Section

Junior Grade

Brugere, G. S., Osmose Wood Pres. Co., 1437 Bailey Ave., Buffalo, N. Y.
Seneff, G. A., U.S.S.S. Barton, F.P.O., New York, N. Y.
Tierson, W. C., Huntington Wildlife Forest, Newcomb, N. Y.

Northern California Section

Student Grade

UNIVERSITY OF CALIFORNIA
Miller, A. R.

Junior Grade

Dougherty, R. H., Route 2, Redding, Calif.
Draves, E. E., 1922 Walnut St., Berkeley, Calif.
Reese, R. A., U.S.F.S., Stonyford, Calif.
Timmers, F. A., 1222 Everett St., El Cerrito, Calif.
Walker, C. M., 829 Yuba St., Richmond, Calif.

Member Grade

Vinacke, J. W., Box 179, Grass Valley, Calif.

Affiliate Grade

Taylor, R. A., 1020 Laurel Lane, Sacramento, Calif.

Northern Rocky Mountain Section

Student Grade

MONTANA STATE UNIVERSITY
Allport, J. L. DeGraot, R. E. Holzweissig, A. C.

Member Grade

Neils, G., J. Neils Lbr. Co., Libby, Mont.

Ozark Section

Junior Grade

Busch, W. H., 3419 Mersington, Kansas City, Mo.
Jarrard, S. E., Umpire Route, Dierks, Ark.
Lloyd, D. W., Jr., Gen. Del., Danville, Ark.
Shaw, D. L., Box B., Owensville, Mo.

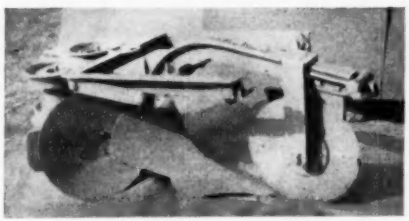
Affiliate Grade

Crownover, J. C., Box No. 7, Grannis, Ark.
Hendricks, B. D., Posey Hotel, Sheridan, Ark.
Lord, J. S., Jr., Umpire, Ark.

Puget Sound Section

Junior Grade

Harrison, H. A., 12057 3rd Ave., N. E., Seattle, Wash.
Kantzer, C. J., 318 E. 88th, Seattle, Wash.
Spada, B., Tieton Rgr. Sta., Naches, Wash.
Zeller, R. E., Route 3, Renton, Wash.



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Buhaly, J., Box 72, Bellingham, Wash.
Hopkins, C. J., 227 W. 11th St., Port Angeles, Wash.

Southeastern Section

Junior Grade

Black, W. B., Box 232, Pell City, Ala.
Geiger, W. B., 757 East Duffy St., Savannah, Ga.
Langley, J. H., Ga. Forestry Comm., Fitzgerald, Ga.
Tomlinson, H. R., 138 W. Hill St., Decatur, Ga.
Wakefield, R. C., Box 52, Heflin, Ala.
Weber, R. L., Box 651, Jacksonville Beach, Fla.

Southwestern Section

Junior Grade

Hicks, O. N., Box 983, Shiprock, New Mexico
Waters, J. W., Heber Rgr. Sta., Holbrook, Ariz.

Upper Mississippi Valley Section

Student Grade

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Szymeczek, F. O.

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Burke, R. E., Jr. Venners, H. W.

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Bulgrin, E., 309B E. 3rd St., Duluth, Minn.
Duncan, J. D., 519 4th St., N. W., Chisholm, Minn.
Patterson, D. E., E. A. Milligan and Son, Ogden, Iowa
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Washington Section

Associate Grade

Erickson, T. A., 2016 G St., N. W., Washington, D. C.

"Strip" Mailing Tried for Journal of Forestry

In place of an envelope, labels were used for mailing copies of the March and April issues of the JOURNAL OF FORESTRY. It is hoped that this type of mailing will prove practical as a saving of approximately $100 monthly can be made.

Comparatively few complaints have been received regarding the poor condition of the JOURNAL upon delivery. In most cases covers have not withstood rough handling received in the Post Offices. A method of binding the JOURNAL is proposed which should better preserve the cover. Another test of label-mailing the JOURNAL may be made later in the year. A change will be made only if acceptable to the membership.

Comment of members on label-type mailing is requested.

Dues Deadline, June 30

Members whose 1952 dues are not paid by June 30 will be in bad standing. Such members will be ineligible to vote, receive the Society's publications, or be a candidate for office until their dues are paid. When sufficient reasons are given, the Council may, upon request, extend period of payment.

John Martin Miller (1882-1952)

John Martin Miller, one of the pioneer forest entomologists of America, died suddenly on March 31, 1952 in Mexico City while serving as a consultant and advisor to the Department of Forest Protection of the Mexican government under sponsorship of the Food and Agriculture Organization of the United Nations. In the short time that he was on this assignment, he made a real contribution towards getting forest entomology established on a sound basis in Mexico as an important phase of forest protection. He was a member of the Society of American Foresters of long standing.

Last November he retired from the U. S. Department of Agriculture, Bureau of Entomology and Plant Quarantine, Division of Forest Insect Investigations, after 41 years of outstanding service in this research field to accept the assignment in Mexico. Foresters, entomologists, and friends both in this country and in Mexico mourn the loss of an outstanding scientist, an inspiring companion, and faithful friend.

Born near Parlier in Fresno County, California on August 31, 1882, John Miller took an early interest in the vast forests which covered the Sierra Nevada. On graduating from Stanford University in the spring of 1907 he became a forest ranger with the U. S. Forest Service on the Sierra National Forest.

Having studied entomology at Stanford under Prof. R. W. Doane, he took an interest in the damage being caused by bark beetles to the pine trees on the Mariposa district of the forest, and wrote a report on the extensive killing of young pines by pine engraver beetles. Dr. A. D. Hopkins, then chief of the newly developed Division of Forest Insect Investigations of the Bureau of Entomology, U. S. Department of Agriculture, insisted that young Ranger Miller be transferred to his organization. Thus on November 16, 1911 the Bureau of Entomology acquired a new entomological assistant, and Miller started his career in the forest entomological field which was to cover four decades of distinguished service in California and Oregon.

His more outstanding accomplishments included studies of the cone and seed insects affecting western conifers, solar heat control of the western pine beetle, the interrelation of bark beetles and forest fires, the effect of low winter temperatures in destroying the western pine beetle, and the rating of ponderosa pine forests according to beetle hazards. More recently he did work in cooperation with the Institute of Forest Genetics in testing hybrid pines for resistance to the pine reproduction weevil.

From 1930 to 1942 he was senior entomologist in charge of the Forest Insect Laboratory of the U. S. Bureau of Entomology and Plant Quarantine at Berkeley, Calif. and through his leadership developed a sound program of forest insect research, region-wide surveys, and supervision of bark-beetle control in the forests of California. He was the author of numerous scientific articles published by the U. S. Department of Agriculture and by technical journals and forestry periodicals. Several new species of insects were named for him. Most important of which is the lodgepole needleminer, *Recurvaria milleri* Busck, a seed chalcid, *Megastigmus milleri* Milliron, and two parasites, *Compoplex milleri* (Rohwer), and *Zacalochlora milleri* Crawford.

He recently completed an exhaustive summary of 40 years of research on the biology and control of the western pine beetle.

All who knew John Miller mourn his loss. His kindness, sympathetic understanding, enthusiasm for new ideas, inspiring guidance to younger workers and associates made staunch friends for him wherever he went. One of the patriarchs of forest entomology in this country has passed, but the influence of the basic work which he did has left an imprint on this field of science which will never be forgotten.

F. P. KEEN.

Forestry News

John D. Coffman Retires

The retirement of John D. Coffman, in charge of the forestry activities of the National Park Service since 1928, became effective May 31.

"His career," Secretary of the Interior, Oscar L. Chapman said, "has exemplified public service of the highest caliber, and his achievements in park and forest protection are recognized by the forestry profession as outstanding. His open-mindedness, loyalty, and fairness in dealing with others are among his conspicuous personal characteristics. Mr. Coffman's very skillful technical direction and his knowledge of the best methods of forest protection are in large part responsible for the present high quality and reputation of the National Park Service's forest protection program."

John Coffman joined the National Park Service in 1928, after 19 years with the U. S. Forest Service. While with that agency he spent 12 years as supervisor of the Mendocino National Forest in California, following technical and administrative assignments in Inyo, Shasta, and Trinity National Forests, also in California.

In the Middle 1920's, when several large forest fires in national park areas focused attention on the need to strengthen protection of park forests, the Forest Service was requested to nominate one of its men experienced in forest protection to head up fire control in national parks. Mr. Coffman was recommended and was appointed fire control expert in July 1928, a title later changed to chief forester. Prior to his appointment, practically no technical direction or planning had been given to the problems of park area forest protection on a service-wide basis, and little had been done to plan, organize, equip, and train protection personnel or to finance these activities generally.

Mr. Coffman energetically analyzed the individual area need for improvement against fire, and also against forest insects and tree diseases, and outlined plans to strengthen protection.

In March 1933, he participated in conferences at the Executive Offices of the President to launch the Emergency Conservation Work Program. He acted as the alternate of former Director Horace M. Albright, who represented the Department of the Interior on the ECW Council, and he directed the program on national park and monument areas from April 1933 to January 1936.

One of Mr. Coffman's outstanding contributions has been the development and maintenance of close cooperative relations with other conservation agencies and organizations. His reputation in this field is indicated by his election to the Council of the Society of American Foresters, 1946-1947. His professional accomplishments in the field of forestry have also been recognized by his election to the grade of Fellow in the Society.

John D. Coffman was born in Allentown, Pa. He attended the College of Arts and Sciences, Cornell University, 1905 to 1907, and then attended Yale University where he received a Master's degree in forestry in 1909.

Forest Products History Foundation

The Forest Products History Foundation has announced the appointment of Elwood R. Maunder as its executive secretary and publicist. A former Minneapolis newspaperman, Mr. Maunder comes to the leadership of the six-year-old Forest Products History Foundation from Columbus, Ohio, where he has been director of public relations for the Ohio area of the Methodist Church since 1949.

As the new head of the Forest Products History Foundation, Mr. Maunder will direct a six-point nationwide program: (1) to collect and preserve the records of the American forest products industry; (2) to establish a bibliography of the industry for the use of writers and scholars; (3) to provide a records service program for all companies in the field of forest products; (4) to publish and encourage publication of special studies, biographies, regional surveys, and original contemporary documents; (5) to write the history of companies; and (6) to promote an educational program.

Associated with and housed by the Minnesota Historical Society of St. Paul, the Forest Products History Foundation is the national repository of American forest history, endowed by private gifts from leading industrialists in the lumber, paper, furniture, and other related industries.

FAO Feilowship Program

The Food and Agriculture Organization of the United Nations has now signed agreements with 39 governments to provide 375 fellowships for agricultural studies in technically advanced countries. By the end of 1952, it is expected, total fellowships provided for in FAO agreements may reach 500.

The FAO fellowship program had something of a slow start, but implementation of the scheme took on increasing importance toward the end of 1951, and now is moving rapidly toward fulfillment of its proper place in FAO's expanded technical assistance program. Already, 55 fellows are studying in foreign fields and schools; 40 more are ready to start their studies within the next few months.

In agreements already signed, Pakistan has been awarded the largest number of fellowships—38. Israel has been granted 33, and Thailand and Yugoslavia 25 each. Approximately 35 percent of the fellows are, and will be, studying in the U.S.A. Some, however, will pursue their studies in so-called underdeveloped countries, such as Indonesia and Ceylon. (Indonesia has one of the most advanced programs in the world for fish culture in ponds).

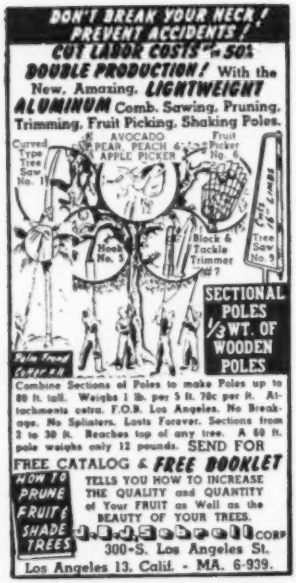
Living allowances for fellows are fixed by the Technical Assistance Board in New York, and based on different living costs in various countries. The amounts may be as much as $300 a month in countries where the standard of living is very high.

The fellowships allow foreign study for periods of two months to one year. Of the 55 fellows already studying abroad, the largest number, 13, are working in the field of forest conservation and management. Another 10 are studying home economics and 6 are learning advanced methods of land and water use.

Penta Questions Answered

Detailed answers to questions frequently asked about pentachlorophenol are contained in a 40-page booklet available from Monsanto Chemical Company, St. Louis 4, Mo.

The 51 questions answered in the booklet are those which Monsanto representatives have been asked most often by lumber dealers, architects, contractors, and home owners.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Consulting Foresters Meet, Elect New Officers

At its annual meeting in Washington, D. C. on April 21, the Association of Consulting Foresters elected the following officers: James Pond, Ithaca, N. Y., president; J. Atwood Whitman, Glendon, N. C., vice-president; Halsey Hicks, Brattleboro, Vt., secretary-treasurer. Members of the executive board, in addition to the officers named above are: Robert Moore, Danville, Pa.; Edward Stuart, Jr., Avalon, Va.; and Clinton Peltier, Redding, Calif.; A. G. Hall of Washington, D. C. was renamed executive vice-president.

Plans for a national advertising campaign to make known the services of consulting foresters were discussed, and a tentative program was outlined, including a full-page ad in the forthcoming *Conservation Yearbook*. Also under consideration is the establishment of local, state, or regional chapters of the association.

Through the courtesy of the American Forestry Association, the meeting was held in the AFA headquarters in Washington. Guest speakers included Fred Hornaday, secretary, American Forestry Association; and Douglas Steinberg, director of public relations, National Lumber Manufacturers Association.

H. E. Brinckerhoff to Retire

H. E. Brinckerhoff, executive secretary-treasurer of the American Pulpwood Association for the last 13 years, will retire July 1.

W. S. Bromley, APA forest engineer for the last three years, will assume the active duties of the secretary-treasurer on May 1 with Mr. Brinckerhoff serving in an advisory capacity. On July 1 Bromley will succeed Brinckerhoff as head of the association.

Mr. Brinckerhoff graduated from the School of Forestry at Cornell University in 1906. After a tenure of service in the advertising business, he filled a number of timber cruising posts both in the United States and Canada, experience that gave him a thorough knowledge of the industry in North America and laid the groundwork for the service he was to give the association in later years. After serving as a lieutenant overseas in World War I, he worked in the Montreal office of the Canadian International Paper Company. On February 1, 1939, he succeeded William Good as secretary-treasurer of the American Pulpwood Association.

Industry leaders say it was largely due to Mr. Brinckerhoff's organizational ability, tact, and wide acquaintance in the industry that led to the founding in 1946 of the APA labor training program under Harry Jefferson; the mechanization program headed by Mr. Bromley; and the program to correct legislation inimical to industry's best interests under Karl Swenning, chairman of the APA legislative committee. Most recent addition to the staff on January 1 was James A. Holecamp as logging engineer.

Mr. Bromley is a forestry graduate of the Pennsylvania State College, with a master's degree from the Yale Forestry School. Prior to his service with APA, Bromley was a consulting forester, managed a 2,000 acre tract of timber in the Lake States, served on the faculty of the forestry school at the University of Michigan, and conducted research for two years at Michigan on logging practices and timber utilization.

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Lumber Manufacturers Announce Award Winners

Scholarship awards of $400 each have been granted to the nation's four outstanding forestry school students majoring in wood utilization.

The award winners, who will receive ten weeks of summer training in the Timber Engineering Company Research Laboratory, Washington, D. C., are: James Micklewright, Iowa State College; Clarence Hart, Virginia Polytechnic Institute; Edwin Wheeler, Syracuse University; and Alan Sliker, Duke University.

These men, selected from a group of 10 nominees, were chosen on the basis of individual and scholastic achievements as well as the recommendations of the deans or department heads of participating colleges and universities.

Following the initial pattern set in 1950, when four other men were awarded scholarships, the association will do what it can to assist these men in obtaining employment in the lumber industry. The purpose of these yearly scholarships is to encourage more of the technically minded forestry school students to prepare themselves for growing opportunities in private wood industries.

Maple Syrup Research At Michigan State College

The Forestry Department, Division of Conservation, Michigan State College, announces the completion of a contract between the Michigan Agricultural Experiment Station and the Agricultural Research Administration, U. S. Department of Agriculture, providing for a four-year research program in maple syrup production. The agreement calls for studies concerning the quality of maple sap and improved methods and techniques for the collection of sap.

The Agricultural Research Administration will provide funds for necessary equipment and the appointment of a research assistant in the Forestry Department. This work will be conducted under the technical direction of Dr. C. O. Willits, in charge of the Analytical Section, Analytic and physical Chemistry Division, Eastern Regional Research Laboratory, Agricultural Research Administration, and Prof. P. W. Robbins, national authority on maple syrup production, Forestry Department, Michigan State College.

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Offers specific help on estimating volume of individual trees, direct estimation of stand volume, and the prediction of stand growth. Stresses throughout, the need for simplicity and low-cost methods. Includes important data made available by many forest agencies, both in this country and abroad.

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HERE IS the up-to-the-minute information needed today on successful forest management plans and practices. Stressing the techniques of American forestry, as contrasted with classical European methods, the book thoroughly covers the general problems of forest organization; the principles and methods of forest regulation; ways to determine allowable cut; effects of economic conditions on possibilities and methods of management.

Reflects the increasing transition from forest exploitation to management, emphasizing the need for bringing timber growth and drain into equilibrium and for managing forests on a sustained-yield basis. Includes typical examples of actual plans for forests of various sizes located in different parts of the country.

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HOW foresters can obtain needed information in *less time*, at *lower cost*, and with *greater precision* by using aerial photographs. Provides essential information on aerial photography; aerial surveying; photo-interpretation; applications to inventory-taking, mapping, and other management operations. Working techniques are explained in detail. Illustration is comprehensive, including photographs, methods, apparatus, diagrams, and working graphs.

"the first complete treatise from which we may review . . . accomplishments of the pioneers, details of aerial surveys, and working principles, limitations, and possibilities of aerial photographs . . . should be widely read and appreciated by foresters in timberland management, teachers, and students."—George W. Stanley, JOURNAL OF FORESTRY.

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Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously, the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiation.

Positions Available

OSMOSE WOOD PRESERVING CO. OF 1437 BAILEY AVE., BUFFALO 12, NEW YORK, has openings for permanent work with good remuneration in pole inspection and brush control. Travel is necessary. **Please write Utilities Division for information.**

Man (with family) to do forestry improvement work on estate in New England. Must be willing to do some hard work. Will live in large farm house on beautiful estate. Write giving references and details.
Box X, Journal of Forestry, Mills Building, Washington 6, D. C.

Positions Wanted

Graduate forester, M.S.F., 1950, major in silviculture, minors photogrammetry, forest management; six months law training. Age 30, married, two children. Four years forestry work in timber cruising, boundary surveying, mapping, timber marking. Three years experience in personnel work in a supervisory capacity. Employed but desire to relocate in teaching, public contact, or sales field.
Box A, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, 24. B.S.F. Idaho 1950, desires permanent employment with forest-owning or wood-utilizing firm in the South. Interest in silviculture. Two years' experience with U. S. Forest Service in fire control and timber stand improvement work. References and details on request.
Box B, Journal of Forestry, Mills Building, Washington 6, D. C.

Forestry graduate, B.S.F., University of Michigan, desires permanent position with a future in industrial or state forestry. Have had two seasons of experience with U. S. Forest Service. Prefer position in South or West.
Box W, Journal of Forestry, Mills Building, Washington 6, D. C.

Graduate forester, 28. B.S., B.S.F., desires position in forest management in Lake States. Some experience with paper mill. Veteran, married, two children. Junior member S.A.F.
Box Y, Journal of Forestry, Mills Building, Washington 6, D. C.

Louisiana Forestry Program

The executive committee of the Louisiana Forestry Association on April 15 mapped a four-point legislative program which would speed up the rehabilitation of denuded timberlands and generally increase the production of timber throughout the state, according to James H. Kitchens, executive secretary. The four points would:

1. Increase the state appropriation to the Louisiana Forestry Commission to permit an increase in tree seedling production for reforestation purposes to 50,000,000 trees next year and a continued expansion upward to 100,000,000 trees per year until the demands of landowners have been met; replace obsolete and worn out fire fighting equipment now in use by the commission; complete the tower detection system for locating fires; add additional fire crews where needed; and to launch a forestry program in the vast Delta hardwood area comprising more than 5 million acres.
2. Establish control of open ranging hogs in pine reforestation areas.
3. Stabalize the ad valorem tax on timberlands without a loss of revenue to the parishes concerned.
4. Ask the legislature to consider ways and means to establish a system providing low-rate loans and fire insurance for reforestation purposes.

The committee also discussed expansion of the Tree Farms Program. (On April 30 eight forest properties totaling more than 61,000 acres were formally certified as Tree Farms bringing to 186,000 acres the total area recognized as certified Tree Farms in Louisiana to date.)

Wildlife Habitat Improvement

The biggest spring wildlife habitat improvement program ever undertaken by the Michigan Conservation Department in the southern third of the state will see over 2,465,000 trees and shrubs planted by farmers, game men, and prisoners.

At least some type of planting will be made in every county in southern Michigan where the bulk of the state hunters reside and hunt.

About 1,200,000 conifer and hardwood trees and fruit-bearing shrubs will be planted by cooperating landowners on some 800 farms. Nearly 375 of the farmers will be receiving habitat stock for the first time this spring.

Twenty or more state game areas will receive nearly 1,000,000 trees and shrubs.

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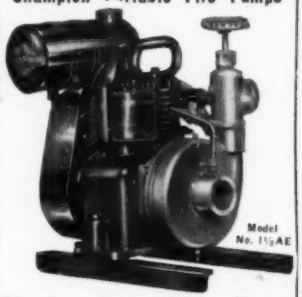

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Victor A. Beede to Retire, M. K. Goddard Named Successor

Victor A. Beede, professor of forest manngement and head of the department of forestry at the Pennsylvania State College, will retire with emeritus rank on June 30 and will be succeeded as head of the department by Maurice K. Goddard, now professor of forestry and director of the Mont Alto branch of the department.

Born in Lowell, Mass., Mr. Goddard received his bachelor of science degree at the University of Maine, where he was a Rhodes scholar candidate, and his master of science degree at the University of California.

Except for a year during which he served as teaching assistant at the University of California, and four years that he served in the Army during World War II, Mr. Goddard has taught forestry at Penn State since his appointment as an instructor in 1935. He was promoted to assistant professor of forestry in 1938, to associate professor and resident director at Mont Alto in 1946, and to professor of forestry in 1949.

During World War II, Mr. Goddard served in Europe with the Adjutant General's Division of Supreme Headquarters, Allied Expeditionary Forces, and for his work was decorated with the Legion of Merit and Bronze Star Medal. He was relieved from active duty in 1946 as a lieutenant colonel.

Mr. Goddard is a member of Xi Sigma Pi, forestry, and Phi Sigma, biological recognition societies, Phi Kappa Phi, scholastic honor society; and Phi Kappa Sigma, social fraternity. He also is a Member of the Society of American Foresters and has written several articles for professional forestry journals.

A native of Massachusetts, Mr. Beede received his bachelor of arts degree at Yale University and his master of forestry degree in the School of of Forestry at Yale.

Prior to his appointment as an instructor in forestry at the College in 1931, he held positions as assistant forester with the Massachusetts Forestry Association, as forest assistant, U. S. Forest Service, Pike National Forest, Colo.; and as assistant state forester in Concord, N. H. He also held industrial positions in Quebec, Canada and in 1927 travelled to the Scandinavian countries to observe woods practice in pulpwood operations for the Brown Corporation, pulp and paper manufacturers of Quebec.

Mr. Beede, on a leave of absence, went to Yale in 1934 where he taught in the School of Forestry. Returning to Penn State in 1935, he was promoted to associate professor of forest management and in 1937, upon the retirement of John A. Ferguson, was named professor of forestry management and head of the department of forestry.

Since 1948, Mr. Beede has served as chairman of the Committee on Civil Service Society of American Foresters; and in 1950-51 he was chairman of the Council of Forestry School Executives. For the past 12 years he has been a member of the Advisory Council, Northeastern Forest Experiment Station, U. S. Forest Service.

Mr. Beede from 1941-47 served as president of the Yale School of Forestry Alumni Association and chairman of the Alumni Executive Council. He has also been a member of the Alumni Board of Yale University since 1941. He is a member of the Canadian Institute of Forestry, of Gamma Sigma Delta, agricultural, and Xi Sigma Pi, forestry, recognition societies; and Alpha Zeta and Zeta Psi, social fraternities. Since 1945, Mr. Beede has served as chairman of the Senate Committee on Academic Standards at the College.

IMPORTANT

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Institute of Forest Products Announces Staff Changes

Professor J. Kenneth Pearce has been named acting technical director of the Washington Institute of Forest Products, Seattle. He succeeds Ralph G. DeMoisy who resigned to accept a position in private industry. Pearce will direct the activities of the institute in addition to his other duties as professor of logging engineering in the College of Forestry, University of Washington.

Professor Pearce has been associated with the institute since its inception as an advisory committee member. He served as its first field supervisor in 1949 when he organized the state-wide unused wood inventory. He has been chairman of the Puget Sound Engineering Council and of the Puget Sound Section, Society of American Foresters, and a consultant on development of forest industries for foreign governments and the International Bank for Reconstruction and Development.

The institute functions to encourage more complete utilization of the timber grown in Washington. Under DeMoisy's direction since December 1949, the unused wood inventory was completed and 20 reports have been published dealing with equipment and methods of handling small timber. During the coming summer field season, Professor Pearce and his staff will undertake several timely projects for the forest industry.

C. Jack Kantzer has been named assistant technical director. Kantzer will supervise the institute's chemical debarking project. He has been employed with the institute since its active work began in June 1949 and has been its logging engineer for the past year. He has written several reports on the small timber logging project.

Baker Continues Planting on Company Lands

During April, The Baker Wood Preserving Company of McArthur, Ohio, completed its tree planting program for 1952. This program of planting open areas on its own holdings was initiated by the company two years ago, since which time it has taken over the management of large holdings owned by the Sunday Creek Coal Company and New York Coal Company of Columbus. This year, the foresters of The Baker Wood Preserving Company supervised the planting on these holdings. A total of 50,000 seedlings were set out this spring.

Forest Products Exhibit To Open In Portland

The biggest permanent forest products exhibit in the world will open its doors in Portland in June.

And it will be housed in the world's biggest log cabin. Portland's famed old "Parthenon of the Forest," the mighty building whose principal supports are 52 gigantic Douglas-fir logs, is being converted into a "Gallery of Trees" featuring three-dimensional exhibits of the modern western forest products industry.

The vast 206-by 102-foot structure will be formally re-opened Sunday, June 8, as the initial event of Portland's annual week-long Rose Festival. The Gallery of Trees will be a permanent exhibit open winter and summer without charge to visitors.

Originally erected in 1905 as part of the Lewis and Clark International Exposition, the vaulted "cabin" once housed exhibits of Oregon's fir, pine, hemlock, spruce, and myrtlewood. Now, through the combined efforts of Pacific Northwest forest products producers and Portland citizens, it will shelter a comprehensive display of modern forest industry methods and products.

Most spectacular of them all will be a replica of a fire lookout station perched high above the floor, commanding a view of the colonnades and exhibits.

Floor exhibits will display modern industrial forestry, logging and sawmilling, plywood making, pulp and paper, the manufacture of hardboard and insulating board, preservative treatment of wood, construction of laminated beams, woodworking, furniture making, and the production of shingles, battery separators, boxes, and other forest products.

Byrd Named Training Director, Gulf States Paper Corp.

The Gulf States Paper Corporation, Tuscaloosa, Alabama, announced April 1 the promotion of J. William Byrd, conservation forester, Forest Development Department, to the position of training director, Personnel Division. Byrd has been in active charge of the Conservation Forestry Section at Gulf States for the past three years, during which time the conservation program has been expanded and intensified. He is a graduate of the School of Forestry, Duke University, and holds the B.S. and M.F. degrees. At the time of the announcement, Mr. Byrd's successor had not been named.

From the time he leaves his home, General Logging Superintendent Tony Zaffel is in touch with the job via the G-E 2-way radio.

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Melichar Named Assistant Regional Forester

Charles Melichar, assistant chief of the Division of Timber Management, U. S. Forest Service, has been named assistant regional forester in charge of the Division of Operation for the North Central Region, with headquarters in Milwaukee, Wis. He succeeds Donald R. Ball, who was transferred to the California Region a few months ago.

Mr. Melichar will be replaced by Bennett O. Hughes, assistant regional forester in charge of timber management in the California Region. Mr. Hughes' job in San Francisco will be filled by Burnett H. Payne, Division of Timber Management, Washington, D. C. All transfers will be effective June 1.

Mr. Melichar was first employed by the Forest Service in 1928 as a technical assistant in the supervisor's office at Hot Springs, Ark. He served as assistant ranger, ranger, assistant forest supervisor, and supervisor on southern national forests before his transfer to the regional office at Atlanta, Ga., as an assistant in the Division of Timber Management. He took over his present position in 1947.

Mr. Hughes, new assistant chief of timber management, has held a variety of timber management positions in large timber producing areas of the Forest Service—California and the Southern Region. His first job with the Forest Service was as field assistant on the Eldorado National Forest in California. Subsequently he served as forest assistant, assistant to the logging engineer of the California Region, forest engineer of the Southern Region, and forest supervisor of the Mississippi National Forests. During World War II he was assistant chief of the Timber Production War Project. He took over his present position in 1944.

Mr. Payne will head up timber management activities in the 18 national forests of California. Before his transfer to Washington, D. C. in 1947 he served in various capacities in the largest Forest Service timber producing region—Washington and Oregon.

His first permanent position with the Forest Service was as foreman of a Civilian Conservation Corps timber survey crew in 1933. He later worked as foreman of a tree planting crew, foreman of a beetle control project, on the compilation and computation of timber data for a natural resource survey, as assistant ranger in charge of timber sales, assistant logging engineer, and associate engineer for the Pacific Northwest Region and as assistant forest supervisor of the Snoqualmie National Forest in Washington.

Hardwood Management Course

A hardwood management course was conducted during the week of May 12 at Lufkin, Tex., by J. A. Putnam, in charge of the Delta branch of the Southern Forest Experiment Station. The Texas Forest Service cooperated with the experiment station in sponsoring the course.

Principles and fundamentals of hardwood management were discussed, and the group visited problem areas in hardwood bottom lands near Lufkin.

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The B-10 Tree Stick, using basal area methods for obtaining tree volumes and growth information, is now available again from the originator, Fred B. Merrill, Zachary, La.

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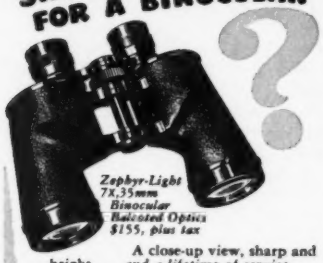

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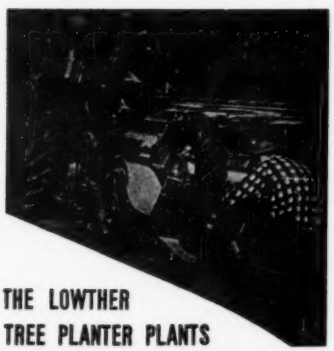

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White Pine Blister Rust Quarantine Extended

Four states — Georgia, Kentucky, South Carolina, and Tennessee—have been removed from the list of states which are designated as noninfected with white pine blister rust in federal quarantine regulations. The removal results from findings of infections on either white pine trees or currant or gooseberry bushes in most of the southern Appalachian region. The amended quarantine regulations became effective April 25.

This change will prevent unrestricted movement of white pines from these four states into Arizona, Colorado, Nevada, New Mexico, Utah, and the southern two-thirds of California. The latter areas comprise the remaining noninfected, white-pine producing regions of the United States.

Another amendment to the regulations eliminates an exception that allowed movement of white pine into noninfected states when the trees were certified as coming from a disease-protected nursery and were intended for reforestation purposes. Noninfected states have indicated that they are able to grow the quantities of white pine seedlings they require for reforestation.

The regulations continue the embargo on all interstate movement of European black currants—the most important alternate host of the disease—into pine-producing states.

Recreation Use of National Forests

Recreation visits to national forests hit an all-time high of 29,900,000 in calendar year 1951, a 9 percent increase over 1950. An ever greater increase in recreation use is expected during the current year.

The U. S. Forest Service reports that close to 15 million visits were made to public recreation areas maintained by that agency. Of these, almost 13 million visits were to campgrounds and picnic areas, 2 million were to winter sports areas, and 100,000 to organized camps.

Approximately 12,000,000 visits were for hunting, fishing, riding, hiking, mountain climbing, and cross-country skiing.

Another 3 million national forest recreation visits were to resorts, camps, and summer homes operated by private organizations or individuals located on national forest land under special use permit.

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Program For Protection of Trees

Dr. George M. Jemison, director of the Northern Rocky Mountain Forest and Range Experiment Station, has announced a long-range program for locating and protecting outstanding timber trees in the region. The purpose of this project is to locate fast-growing trees of high quality to provide a parent stock for better timber crops in the future.

The University of Idaho, Washington State College, and several other federal agencies have joined with the experiment station in sponsoring this project. All foresters will be asked to be on the lookout for superior timber trees.

Wood Preservation Film

The Dow Chemical Company has recently released a new sound motion picture in color with the title "Treat Wood Right."

This is the first motion picture devoted to the wood preservation industry and its increasing importance. It shows that properly treated wood has greater life and wider usefulness than generally recognized. It shows the items that make for the right treatment of wood—the equipment, the preservatives, and the experts that serve the industry.

This is a 16-mm film requiring twenty minutes for showing. Prints may be secured on loan by writing to the Public Relations Department, Dow Chemical Company, Midland, Mich.

Tick and Chigger Control

Outdoor personnel can now be protected from ticks and chiggers. A low pressure bomb has been developed to impregnate the outer clothing.

The Whitmire Research Laboratories have produced a repellent under the trade name "Ticks-Off" and supplied it to lumber companies throughout the southern states. In 1950, the demand became so great for "Ticks-Off" in fields other than forestry that it was placed in a low pressure bomb and offered for sale in select locations during 1951. This year it is being made available throughout the South, Southeast, and West. One 8-second treatment gives a full day's protection with a cost per treatment of approximately 3 cents.

When writing to advertisers please mention that you saw it in the JOURNAL OF FORESTRY.

Engineer, Park Service, Retires

The retirement of Chief Engineer Frank A. Kittredge of the National Park Service, became effective May 31. Mr. Kittredge, before entering National Park Service work, had served with the Bureau of Public Roads of the Department of Agriculture for ten years, with time out for service with the Army Engineers for 13 months in France during World War I.

While with the Bureau of Public Roads, he, in 1924, surveyed, designed, and got ready for contract the famous Going-to-the-Sun Highway project in Glacier National Park, Mont. It was the bureau's first major highway through mountainous country and set a policy of location and construction for the park system.

The following year the National Park Service requested the Bureau of Public Roads to assign Mr. Kittredge to the preparation of an over-all program for the construction of main line roads in the national park system.

When in 1927 the National Park Service decided to set up an engineering division, the choice of a chief logically fell upon Mr. Kittredge.

In 1937, when permanent regionalization of the National Park Service became effective, Mr. Kittredge was appointed regional director of Region Four, with headquarters in San Francisco. In 1947, Mr. Kittredge returned to the position of chief engineer of the National Park Service, with headquarters in Washington, D. C.

Grade Classification of Inferior Hardwoods

Value of low-quality logs may now be determined from a study completed by the Texas Forest Service. Information on this subject is contained in Technical Report No. 4, *Log Grade Classification Based on Standard Lumber Recovery for Inferior Upland Hardwoods in East Texas*, by Paul R. Kramer of the Forest Products Department.

Much of the potential pine-growing area of Texas is supporting low-quality hardwoods. These are principally southern red oak, post oak, and sweet gum. The technical report is an aid in determining what profit may be expected when converting low-quality hardwood logs to lumber. This is accomplished by grouping the logs into quality classes based on lumber value.

Several Texas timberland owners and lumber companies cooperated in the study.

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- RCA "long-haul" system provides 24 voice channels plus service channel. Again, any voice channel can be split into 8 to 16 teletype or control channels.

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Fire Fighter Honored Posthumously

California recognized one of her unsung heroes in the battle against forest fires when Mrs. Vivian I. Smith of San Francisco accepted on April 18, the James McLachlan Bissell medal for heroism awarded posthumously to her son, Forestry Foreman Gerald B. O'Reilly of Sonora. O'Reilly was burned to death in an attempt to save the lives of three fellow fire fighters on the Los Palitos Fire in San Luis Obispo County on July 5, 1950.

Wm. S. Rosecrans, chairman, California Board of Forestry presented the Bissell Medal at a joint meeting of the State Board of Forestry and California Fire Prevention Committee.

The James McLachlan Bissell Award was created by Harry B. Bissell, manufacturer of Pasadena in memory of his son who lost his life as a result of a rattle snake bite. The trust provides that the award shall be made to any forest officer, forest guard, or other forest employee for unusual and outstanding service or devotion of duty, or to any other citizen who by some act of heroism or intelligent action prevents or lessens damages to the forests or watersheds of California by fire; or who safeguards the lives of those engaged in fighting forest or brush fires.

Woods Hogs vs. Pine Logs

Woods hogs roaming at large in the pine areas of Louisiana are a prime factor preventing reforestation on approximately 1,500,000 acres of nonproductive timberlands, according to a booklet, *Woods Hogs vs. Pine Logs*, published by The Louisiana Forestry Association.

Written by Walter Hopkins, research forester, Southern Forest Experiment Station, the booklet presents in a factual and vivid way the damages hogs do to young pine trees and the loss in wealth the state is suffering as a result.

The booklet points out that one hog can destroy five or six pine seedlings in one minute and as many as 210 in forty minutes, according to actual field tests.

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Increased Use of Wood Preservatives

The amount of wood materials treated with preservatives increased 4 percent during the past year, according to statistics compiled by the Forest Service and based on reports from 277 wood treating plants throughout the country. These represent more than 95 percent of the total capacity of the industry. Only 16 plants have not yet made reports.

The amount of material treated in calendar year 1951 totaled 300,081,741 cubic feet. This compares with 288,787,675 cubic feet treated in 1950. Significant increases were noted in the preservative treatment of lumber, piles, switch ties, construction timbers, and cross arms. Slight increases were made in the number of cross-ties and fence posts treated. The treatment of poles showed a slight drop.

The consumption of wood preservatives increased generally. Creosote and tar use increased 9 percent over 1950. The use of salts increased 20 percent. Petroleum however, decreased about 6 percent and zinc chloride and Protexol fell off slightly.

A copy of this preliminary report may be obtained from the Division of Forest Economics, U. S. Forest Service, Washington 25, D. C.

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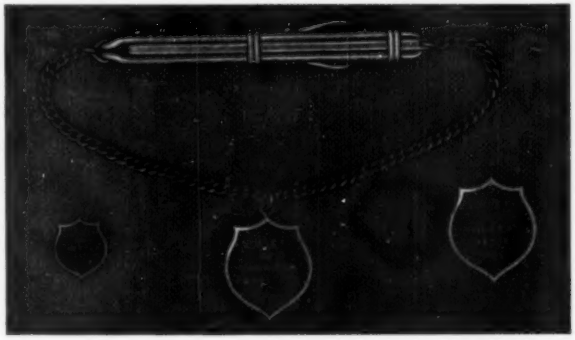

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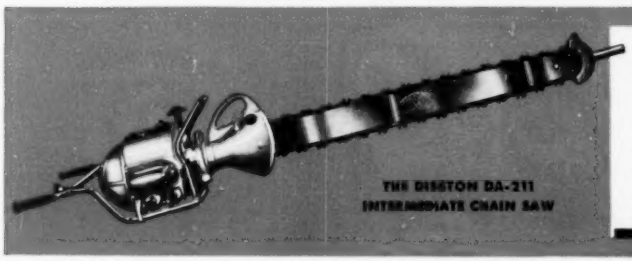

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